

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

The
AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

VOLUME 62

JULY TO DECEMBER, 1949



CHARLES C THOMAS : SPRINGFIELD, ILLINOIS

1949

COPYRIGHT, 1949

By AMERICAN ROENTGEN RAY SOCIETY, INC.

CONTENTS OF VOLUME 62

ORIGINAL ARTICLES

Cushing's Disease—Pituitary Basophilism. Caldwell Lecture, 1947	<i>Merrill C. Sosman, M.D.</i>	I
The Development of the Tautograph and the Advantages of Automatization in Cardiovascular Angiography	<i>Wendell G. Scott, M.D.</i> <i>Sherwood Moore, M.D.</i>	33
Pulsating Exophthalmos Due to Defective Development of the Sphenoid Bone	<i>E. Graeme Robertson</i>	44
Solitary Tumors of the Chest; The Differen- tial Diagnosis in Fifty Proved Cases	<i>Robert K. Arbuckle, M.D.</i> <i>Felix G. Fleischner, M.D.</i>	52 65
Bronchial Peristalsis		
Double Contrast Roentgenograms of the Stomach: An Additional Aid in Diagno- sis	<i>Everett L. Pirkey, M.D.</i>	70
The Relation of Therapeutic Radiology to Clinical Medicine	<i>Arthur U. Desjardins, M.D.</i>	75
Pyelography by Rapid Injection: Descrip- tion of an Improved Method and Re- sults in 200 Cases	<i>Louis J. Friedman</i> <i>Herbert Lobsenz</i> <i>Russell Fauernig</i>	84
Physical Characteristics of Soft Roentgen Rays	<i>E. Dale Trout</i> <i>R. M. Gager</i>	91
Roentgenologic Control of Ureteral Calculi on the Operating Table	<i>Ernest Newman, M.D.</i> <i>Lester Narins, M.D.</i>	113
Graduate Education in Radiology. Caldwell Lecture, 1948	<i>B. R. Kirklin, M.D.</i>	159
Congenital Obstructions of the Respiratory Tract. I. Tracheal Malformations	<i>William A. Evans, Jr., M.D.</i>	167
Congenital Obstructions of the Respiratory Tract. II. Bronchial Malformations	<i>William A. Evans, Jr., M.D.</i> <i>E. L. Jenkinson, M.D.</i>	177 185
Lesions of the Diaphragm		
Reticulo-endotheliosis; Hand-Schüller-Chris- tian Disease and the Rarer Manifesta- tions	<i>William A. Wallace, B.A., M.D., F.A.C.R.</i>	189
Nodular Pulmonary Densities Due to Scars of Multiple Pulmonary Infarcts	<i>Charles E. Grayson, M.D.</i>	208
The Clinical and Roentgen Manifestations of Pneumonia Due to <i>Bacillus mucosus</i> <i>capsulatus</i> (Primary Friedländer Pneu- monia)	<i>Max Ritvo, M.D.</i> <i>Francis Martin, M.D.</i>	211
A Case of Aneurysm of the Ductus Arterio- sus with Postmortem Roentgenologic Study after Instillation of Barium Paste	<i>John H. Kneidel, M.D.</i>	223
Coccidioidal Granuloma of Bone	<i>David Miller, M.D.</i> <i>J. W. Birsner, M.D.</i> <i>Gordon J. Culver, M.D.</i> <i>Joseph P. Concannon, M.D.</i> <i>E. C. Koenig, M.D.</i>	229
Calcification in Intraspinal Meningiomas	<i>John G. Bielawski, M.D.</i> <i>Maurice Tatelman, M.D.</i>	237
Intracranial Calcification in Encephalotri- geminal Angiomatosis	<i>V. V. Brunst</i> <i>E. A. Sheremetieva-Brunst</i> <i>H. E. Johns</i>	247
Biological Effects of Roentgen Rays of Vari- ous Wavelengths	<i>E. K. Darby</i> <i>R. N. H. Haslam</i> <i>L. Katz</i> <i>E. L. Harrington</i>	252
Depth Dose Data and Isodose Distributions for Radiation from a 22 mev. Betatron		257

Roentgen Therapy as the Sole Method of Treatment of Cancer of the Breast	<i>Dr. F. Baclesse.</i>	311
Treatment and Results in Cancer of the Breast	<i>Elis Berven, M.D.</i>	320
Treatment and Results in Cancer of the Breast	<i>Sir Stanford Cade, K.B.E., C.B., F.R.C.S.</i>	326
The Treatment and Results in Cancer of the Breast at the Presbyterian Hospital, New York	<i>C. D. Haagensen, M.D.</i>	328
Cancer of the Breast	<i>Dr. Robert McWhirter</i>	335
Treatment and Results in Cancer of the Breast	<i>Grantley Walder Taylor, M.D.</i>	341
Cancer of the Breast	<i>Dr. Brian W. Windeyer</i>	345
Automatic Roentgen-Ray Roll-Film Magazine for Angiocardiography and Cerebral Arteriography	<i>Charles T. Dotter, M.D.</i>	355
	<i>Israel Steinberg, M.D.</i>	
	<i>Harold L. Temple, M.D.</i>	
Generalized Progressive Scleroderma	<i>Gerhart S. Schwarz, M.D.</i>	359
	<i>Olaf K. Skinsnes, M.D., Ph.D.</i>	
Ulcer Associated with Diaphragmatic Hernia	<i>Glenn F. Miller, M.D.</i>	368
	<i>Howard P. Doub, M.D.</i>	
Relative Incidence of Bone Lesions over a Thirty-seven Year Period	<i>Sherwood Moore, M.D.</i>	375
The Roentgenologic Examination of the Cervical Spine	<i>Joseph C. Bell, M.D.</i>	380
	<i>James B. Douglas, M.D.</i>	
Bone Metastasis in Malignant Melanoma	<i>Daniel Wilner, M.D.</i>	388
	<i>Robert L. Breckenridge, M.D.</i>	
Collapse of the Vertebral Bodies in Sickle Cell Anemia	<i>William A. Henkin, M.D.</i>	395
Evaluation of Planigrams in Pulmonary Tuberculosis	<i>Philip Morgenstern, M.D., F.A.C.P.</i>	402
	<i>Charles E. Carr, M.D.</i>	
	<i>Walter L. Nalls, M.D., F.A.C.P.</i>	
The Syndrome of Arteriovenous Fistula of the Lung	<i>Peter Crane, M.D.</i>	418
	<i>Henry H. Lerner, M.D.</i>	
	<i>Edwin A. Lawrence, M.D.</i>	
Low Intensity Radium Element Needles. Janeway Lecture, 1949	<i>Charles L. Martin, M.D.</i>	467
Tracheo-esophageal Constriction Produced by the Right Aortic Arch and Left Ligamentum Arteriosum	<i>Edward B. D. Neuhauser, M.D.</i>	493
The Roentgenographic and Angiocardiographic Aspects of (1) Aberrant Insertion of Pulmonary Veins Associated with Interatrial Septal Defect and (2) Congenital Arteriovenous Aneurysm of the Lung	<i>Arthur Grishman, M.D.</i>	500
	<i>M. H. Poppel, M.D.</i>	
	<i>R. S. Simpson, Captain, M.C., U.S.N.</i>	
	<i>M. L. Sussman, M.D.</i>	
The Time Factor in Cerebral Angiography and an Automatic Seriograph	<i>J. M. Sanchez-Perez, M.D.</i>	590
	<i>Ray A. Carter, M.D.</i>	
Non-pathologic Variations in Relationship of the Upper Cervical Vertebrae	<i>Lester W. Paul, M.D.</i>	519
	<i>William W. Moir, M.D.</i>	
Pulmonary Adenomatosis with a New Laboratory Finding	<i>W. H. Hatfield, M.D.</i>	525
	<i>John E. Hill, M.D.</i>	
Multiple Charcot Joints	<i>Raymond D. Goodman, M.D.</i>	531
Roentgenologic Findings in Osteomyelitis Following Bone Marrow Infusions in Infants	<i>E. Clinton Texter, M.D.</i>	534
	<i>W. A. Irwin, M.D.</i>	
	<i>D. H. Kaump, M.D.</i>	
Changes in Coagulability of the Blood after Radiation Therapy	<i>Seymour B. Silverman, M.D.</i>	541
Effect of Atropine on Acute Irradiation Sickness in Mice	<i>John C. Larkin, M.D.</i>	547

The Time Factor in Lethal Effects of Total Roentgen Irradiation in Triton	{ <i>V. V. Brunst</i> <i>E. A. Sheremetieva-Brunst</i> }	550
Biological Evaluation of 20 Million Volt Roentgen Rays. III. Recessive Sex-linked Lethals in <i>Drosophila melanogaster</i>	{ <i>Wilbur M. Luce</i> <i>Henry Quastler</i> <i>Lester S. Skaggs</i> <i>Z. S. Gierlach</i> <i>A. T. Krebs</i> }	555
Radiation Effects on 2,3,5-Triphenyltetrazolium Chloride Solutions	{ . }	559
Oil Contrast; A New Method of Examination of the Gastric Mucosa	<i>Cesare Gianturco, M.D.</i>	564
Screen Intensification Systems and Their Limitations	{ <i>Ralph E. Sturm</i> <i>Russell H. Morgan</i> <i>Russell H. Morgan</i> <i>John F. Roach</i> }	617
Clinical Potentialities of Screen Intensifying Systems	{ . }	635
Infectious Mononucleosis; with Special Reference to Roentgenographic Manifestations	<i>James J. McCort, M.D.</i> <i>Israel Steinberg, M.D.</i> <i>Charles Dotter, M.D.</i> <i>George Peabody, M.D.</i> <i>George Reader, M.D.</i> <i>Leonard Heimoff, M.D.</i> <i>Bruce Webster, M.D.</i> }	645
The Angiocardiographic Diagnosis of Syphilitic Aortitis	{ . }	655
Intravenous Urography in the Study of Vesical Neck Obstructions	<i>William J. Engel, M.D.</i>	661
Deformities of the Bladder Secondary to Ureteral Stone	{ <i>Bernard Hall, M.D.</i> <i>Harold O. Peterson, M.D.</i> }	670
Roentgen Diagnosis of Cholesteatoma of the Middle Ear	<i>Jules G. Waltner, M.D.</i>	674
Malignant Degeneration of Benign Giant Cell Tumor of Bone	{ <i>T. Leucutia, M.D.</i> <i>James C. Cook, M.D.</i> }	685
The Value of Upright Roentgenograms of the Maternal Pelvis at or Near Term	{ <i>H. R. Crews, M.D.</i> <i>A. O. Hampton, M.D.</i> <i>J. P. Moore, M.D.</i> }	707
Chondroma of the Larynx	{ <i>Maxwell D. Ryan, M.D.</i> <i>Judah Zizmor, M.D.</i> }	715
Neutron and Roentgen-Ray Effects on Protein Content of Rat Intestine	{ <i>M. H. Voss, V.M.D.</i> <i>J. O. Ely, Ph.D.</i> }	718
Neutron Effects on Alkaline Phosphatase of Rat Intestine	{ <i>M. H. Voss, V.M.D.</i> <i>J. O. Ely, Ph.D.</i> }	723
Training of the Blind for Dark Room Technicians	<i>Sherwood Moore, M.D.</i>	726
The Relationship of the Roentgenographic Appearance of the Pulmonary Artery to Pulmonary Hemodynamics	{ <i>R. F. Healey</i> <i>J. W. Dow</i> <i>M. C. Sosman</i> <i>L. Dexter</i> }	777
The Fate of Oil Particles in the Lung and Their Possible Relationship to the Development of Bronchiogenic Carcinoma	<i>L. R. Sante, M.D.</i>	788
A Case of Bilateral Pneumothorax, Associated with Pneumomediastinum Pulmonary Edema, and Subcutaneous Emphysema, Occurring during Labor: Mediastinal Air Block	{ <i>Nathan James Furst, M.D.</i> <i>Lewis R. Lawrence, M.D.</i> }	798
A Study of the Effect of Certain Drugs on Curling of the Esophagus	{ <i>A. Sheinmel, M.D.</i> <i>C. A. Priviteri, M.D.</i> <i>M. H. Poppel, M.D.</i> <i>Jack Friedman, M.D.</i> <i>J. Richards Aurelius, M.D.</i> <i>Leo G. Rigler, M.D.</i> }	807
Emphysematous Cholecystitis	{ . }	814

Lipomas of the Gastrointestinal Tract . . .	<i>William L. Palazzo, M.D.</i>	823
Dilatation of the Jejunum	<i>Lloyd E. Hawes, M.D.</i>	831
Roentgen Demonstration of Fetal Death (Gas within the Fetus) and Uterine Rupture	<i>Charles N. Davidson, M.D.</i>	837
Sarcoma of the Urinary Bladder in Children	<i>George W. Henry, M.D.</i>	843
Partly Duplicated Colon. Case Report	<i>Bela Gondos, M.D.</i>	855
The Roles of Surgery and Radiology in the Treatment of Cancer	<i>L. Henry Garland, M.D.</i>	858
An Analysis of the Physical Factors Con- trolling the Diagnostic Quality of Roentgen Images. V. Unsharpness	<i>Russell H. Morgan, M.D.</i>	870
The Extended Tube Technique in Intra-oral Roentgenography	<i>Robert M. Appleman, D.D.S.</i>	881





MERRILL C. SOSMAN

CALDWELL LECTURER, 1947

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 62

JULY, 1949

No. 1

CUSHING'S DISEASE—PITUITARY BASOPHILISM

CALDWELL LECTURE, 1947*

By MERRILL C. SOSMAN, M.D.

Radiologist to the Peter Bent Brigham Hospital; Clinical Professor of Radiology, Harvard Medical School
BOSTON, MASSACHUSETTS

INTRODUCTORY REMARKS

By ARTHUR C. CHRISTIE, M.D.

The Caldwell Lecture for which we are assembled here tonight was established by the American Roentgen Ray Society in the year 1920, through the initiative of Dr. James T. Case, who was then President of the Society. It is a great privilege to have Dr. Case here tonight.

The Lecture has become increasingly important through the years, not only because of our increasing realization of the greatness of the man for whom it was founded, but because of the growing prestige of the oldest of American radiological societies and the now imposing list of illustrious men who have from year to year delivered it.

Eugene Caldwell has now been dead for thirty years and few remain who knew him intimately. Although I was much younger than he, it was my privilege to be in somewhat intimate contact with him from time to time during the last year of his life. He was working intensively to perfect a stereofluoroscope, hoping that it could be used in the first World War in which we were then engaged, and knowing that his own time was rapidly running out.

He impressed me then as a great man. He had many of the qualities that contribute to greatness of mind and soul, but there was one

dominant characteristic which stands out vividly in my memory of him to this day. It was the courage with which he faced the hard problems and circumstances of his waning days. I do not mean the kind of courage that most of us have, which can rise to meet some great crisis, or even catastrophe, but the kind of courage which carries on the ordinary affairs of life in spite of grinding physical pain, and in the knowledge that death awaits to end all activity in a very short time. Under such circumstances I remember Caldwell, pursuing his work with enthusiasm, meeting difficulties with good nature and a constant quiet humor.

There was what I can only describe as a radiant quality about the man that remains with me to this day as my most vivid memory of his personality. Aldous Huxley has aptly said that experience is not what happens to a man; it is what a man does with what happens to him. It is the prize he receives for the way in which he deals with the accidents of existence. Caldwell dealt with the circumstances that surrounded him in his day in such a way that he has left a great heritage to us, his successors in radiology, and we commemorate his achievements again this year in the Caldwell Lecture.

Merrill Sosman, who is to deliver the Lec-

* Delivered before the Forty-eighth Annual Meeting of the American Roentgen Ray Society, Atlantic City, New Jersey, September 16-19, 1947.

ture tonight, is a worthy successor to this pioneer in radiology. He has had an important part, by original contributions and as a teacher and leader, in the progress of radiology during the present generation. His career has in it encouragement for every young American radiologist who may be just starting his life's work.

He was born and reared in a small town of the Middle West and graduated from a typical middle western university, albeit one of the best. I remember in my own graduating class there were those who graduated *cum laude* (with praise), those who graduated *magna cum laude* (with great praise), and one who even graduated *summa cum laude* (with the highest praise). A classmate, who remembered his Latin better than most, said that the rest of us graduated *mirabile dictu* (wonderful to tell).

I do not know in which of these categories Dr. Sosman found himself at graduation, but his career may well be characterized by the words "mirabile dictu," for it is really a marvelous story to tell. I wish I had time to tell it in detail but I must be very brief in order that you may come unwearied to his Lecture.

After graduation at the University of Wisconsin he entered the Johns Hopkins Medical School and graduated in medicine just at the beginning of the first World War and soon found himself in the Medical Corps of the Army. It was there that he became interested in radiology, having become, like the present speaker, a radiologist "by order of the Surgeon General."

When the war was over, he continued his training under one of the greatest teachers of radiology that America has produced, George W. Holmes. From his course of training he went directly to the Peter Bent Brigham Hospital to be associated as radiologist with Harvey Cushing. There his entire life's work up to the present moment has been done. How productive, how even brilliant that work has been, I need not relate to an audience of radiologists. He has there exemplified all of those qualities which contribute to the making of a great radiologist and a great physician.

He comes tonight, at the zenith of his career, to acquaint you with some of the results of his work.

Dr. Sosman, the American Roentgen Ray Society has formerly honored you by electing you President of the Society. Tonight it gives you one of the highest honors that it can be-

stow by naming you the Caldwell Lecturer. In bestowing these and other honors upon you, the Society feels not only that it has honored you, but that you do honor to the Society by your entire career.

Ladies and gentlemen, it is my great personal honor and privilege to present to you the Caldwell Lecturer, Dr. Merrill C. Sosman, Professor of Radiology at Harvard University Medical College. Dr. Sosman!

CALDWELL LECTURE

PROLEGOMENON

To be chosen to give the Caldwell Lecture is not only a great honor, but it is also a great responsibility. Named for Eugene Wilson Caldwell, one of the pioneers and martyrs in our specialty, and initiated by Dr. James T. Case in 1920, this is the twenty-sixth of the series to be given before this Society. Eleven of these "lectures" have been given by roentgenologists, seven of them former presidents of this Society, four from abroad. Nine have been given by medical but non-roentgenological colleagues, and five by physicists. The subjects of the lectures have been about equally divided between general or abstract topics and specific or concrete talks on clinical matters of particular interest to the speaker, and, I hope, to his audience. Just twenty-three years ago (1924) we met at Swampscott, Massachusetts, and Dr. Gösta Forssell gave the Caldwell Lecture on "Experiences on the Permanency of the Radium Cure in Malignant Tumors." That year I became a member of this Society. Dr. George W. Holmes sponsored me for membership. Dr. William Duane allowed me to observe him at work in his laboratory at Harvard, and Dr. Harvey Cushing and the whole staff at the Brigham Hospital also aided in the continuous post-graduate education which I have enjoyed for the past twenty-three years. All of us owe our intellectual debts to our predecessors upon whose work we build, and it is well to pause at least once a year to acknowledge that debt as we do tonight.*

* The accepted meaning of "lecture" in the English universities is "a rehearsal of a lesson." (Webster.) This is a lesson I have learned (and am still learning) since 1930.

Eugene Wilson Caldwell was a symbol of his age and of his period. Born in Savannah, Missouri, he grew up and went to school during the time when electricity was developing and growing, with new uses being found for it almost daily. His training at school and college was in electrical engineering and his early work was with submarine telephones, wireless, and other electrical specialties. Acquiring a photographer's outfit in 1897 which included a roentgen-ray machine, he became interested in our specialty and from then on spent most of his time doing roentgen-ray work and improving roentgen-ray apparatus and tubes in his own workshop. Realizing the necessity of having an M. D. degree in order to practice roentgenology, in 1901 he entered Bellevue Medical School, where he was already on the faculty as Director of the Edward N. Gibbs Memorial X-ray Laboratory. He had opened and equipped the X-ray Laboratory at Bellevue Hospital in 1900 with the help of the Gibbs Foundation, and was in charge of the department until he resigned in 1908. His whole life history reads very much like that of Walter Dodd, in Boston, and to both of them, who died of X-ray cancer, one in 1916, the other in 1918, as well as to many others of their generation, these lectures are dedicated. Caldwell's published works dealt mostly with clinical subjects, but his practical improvements in machines, tubes, and equipment equalled his literary contributions in importance. As early as 1903, Caldwell and Pusey published a book "The Practical Application of the Roentgen Ray in Therapeutics and Diagnosis," but Caldwell is best remembered in our specialty for his work "Skiagraphy of the Sinuses," in which he advocated the frontonasal projection now known as the "Caldwell position." He also reported a study on the epiphyseal development in children, trying to correlate it with their mental development, but concluded that there was no constant relationship. Of particular interest, in view of the subject tonight, was his study of the sella turcica

in epileptic patients, a study with essentially negative results. Other subjects, indicative of his wide range of interest, were articles on renal calculi, gallbladder examinations, and the stereoscopic fluoroscope, which was nearing perfection when he died in 1918.

The title of this evening's talk could just as well have been "Pleasure and Satisfaction in Roentgenology" rather than "Cushing's Disease—Pituitary Basophilism." It has been a constant source of pleasure and satisfaction to be in a teaching hospital where research and investigation are considered a privilege as well as a duty and which are, *ipso facto*, a part of one's job. To take part in some of these investigations, even the small and insignificant part I have taken, gives one a thrill and a satisfaction which no other work can do.

The work of a roentgenologist in a large hospital is necessarily a reflection of the interests of his staff. If there is clinical material unusual in number or type, he should seize the opportunity to develop special competence along those lines and contribute his experiences to his fellow workers who do not have access to the same rich vein of material. It is only the decent thing to do and no one deserves praise or commendation for doing his share toward solving some of the many unsolved problems in medicine.

Pituitary basophilism was suggested in 1930 by Teel and Cushing^{*62} as a possible addition to the well known hyperpituitary state of acromegaly and the hypopituitary state of the patients with chromophobe pituitary adenomas. It remained for one of Cushing's students, H. M. Teel,⁶¹ first to observe such a patient and to predict (in 1931) the basophilic adenoma which was subsequently found at autopsy.

* Cushing was writing a paper with Teel on the growth hormone and the sex hormone of the pituitary gland. In reviewing the literature, he found a patient reported by Raab⁵⁸ and Kraus⁶¹ in 1924 whose clinical condition closely simulated that of a patient then in the hospital (our case 1, E. F.). Cushing predicted a basophil adenoma in his patient, as had been found at autopsy in Raab's patient, but he had to wait until 1935 for postmortem verification.



FIG. 1. Harvey Cushing, 1869-1939. (Photograph by Walter Boyd, M.D.)

With characteristic energy, Cushing collected and assembled all the material then available (only 12 cases, including 2 of his own patients), with an enormous amount of collateral and supporting evidence, and described the syndrome of "pituitary basophilism." The assembled material was first presented formally before the New York Neurological Society on January 5, 1932. Also with characteristic facility, he presented the same material next before the Harvard Medical Society, January 20, 1932, then as the Alpha Omega Alpha Lecture at New Haven* on February 24, 1932, and again to the Johns Hopkins Medical Society on February 29, 1932. The complete article was first published in the *Bulletin of the Johns Hopkins Hospital* in March, 1932,¹⁵ and immediately aroused great interest as well as a storm of criticism and dissension over his deductions. Subse-

* The room which was readied for Cushing's talk was filled to overflowing before the address was begun. The meeting was adjourned to a larger auditorium, but unfortunately no lantern or screen was available, and Cushing had to describe his patients rather than project their photographs on the screen. But he rose to the occasion and charmed his audience with his masterly word pictures. (Fulton²¹.)

quent amplifications of this original concept were published in the *Journal of the American Medical Association* in July, 1932,¹⁶ adding 4 cases, including 2 new Brigham Hospital patients whose progress I shall report on tonight. His third paper on the subject was given as the Harvey Lecture in 1933¹⁷, entitled "Dyspituitarism; Twenty Years Later." This was his second Harvey Lecture and one in which he contrasted the knowledge of the pituitary gland in 1912, at the time of his first Harvey Lecture, with the knowledge twenty years later.

It is unnecessary, I am sure, to remind you of what an important part Harvey Cushing (Fig. 1) played in the development of knowledge concerning the pituitary body.† It should be interesting, however, to review briefly some of the historical land-

† When I joined the Brigham Staff in 1922, I was gently criticized by an Important Person for speaking of the "pituitary gland," and was told that there was no reliable evidence that the anterior lobe secreted anything which would justify calling it a gland. Hence the term "pituitary body."

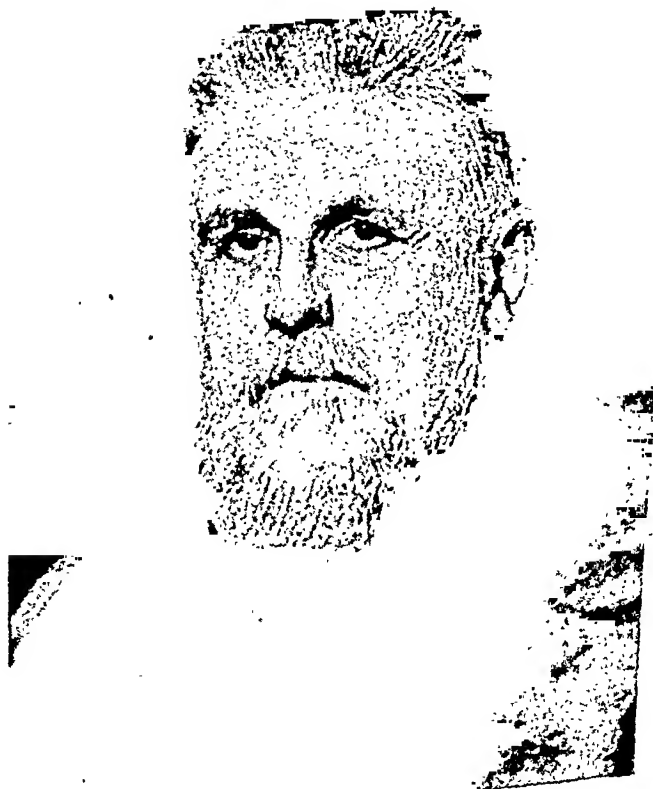


FIG. 2. Pierre Marie, 1853-1940.

marks in the recognition of pituitary tumors and their amazing effects upon the human organism due to changes in its secretions.

The great French neurologist, Pierre Marie (Fig. 2), is universally credited with the first description⁴⁷ in 1886 of acromegaly and its relation to a tumor of the hypophysis, but the condition had been described previously (in 1884) by Fritsche and Klebs.²⁸ Marie reported 2 cases of his own and collected 5 cases from the literature (Fig. 3). Only one patient (Henrot's) had been autopsied, a large pituitary tumor having been found, but Marie did not attribute the condition to the pituitary gland. His main thesis was the differentiation of this condition, which he named "acromégalie," from Paget's disease, leontiasis ossea, and myxedema.

In 1887 Minkowski⁴⁹ reported one case and called attention to the case reported in 1884 by Fritsche and Klebs, who had found at autopsy enlargement of both thymus

Marie considered the condition to be one of general nutritional disturbance, modified by local vascular supply and by inherent embryological tendencies.*

SUR DEUX CAS D'ACROMÉGALIE

HYPERTROPHIE SINGULIÈRE NON CONGÉNITALE
DES EXTRÉMITÉS SUPÉRIEURES, INFÉRIEURES ET CÉPHALIQUE

Par Pierre MARIE
Chef de laboratoire adjoint à la Salpêtrière.

Les deux observations qui font l'objet de ce travail ont été recueillies dans le service de M. le Professeur Charcot; elles ont trait à une affection qui n'a pas encore été isolée et décrite dans son ensemble; cependant il semble bien qu'on soit là en présence d'une entité morbide spéciale, car chez tous les malades on retrouve d'une façon surprenante le même aspect, les mêmes caractères. Cette affection est-elle très rare? nous l'ignorons; pour notre part nous en avons observé deux cas simultanément, mais dans les recherches bibliographiques assez étendues auxquelles nous nous sommes livrés nous n'avons pu en retrouver qu'un très petit nombre d'exemples¹.

FIG. 3. Marie's report of "Two Cases of Acromegaly."

and the pituitary gland. They had assumed the thymus to be the cause of the condition and explained the enlarged pituitary gland as part of the generalized overgrowth. Minkowski, however, attributed the acromegaly to the enlarged pituitary gland, reasoning by analogy with thyroid gland function and myxedema.



FIG. 4. Alfred Fröhlich, 1871-. (Photograph taken in 1945.)

It was fifteen years later that Fröhlich²⁹ (Fig. 4) published his case entitled "Pituitary tumor without acromegaly," and described the syndrome of a short fat, sexually undeveloped fifteen year old boy (Fig. 5). This is now known as "Fröhlich's syndrome." Unknown to him, Babinski⁶ the French neurologist, had described a

* For interesting and complete historical details concerning the development of theories and knowledge about acromegaly see Davidoff.¹⁸

Originalartikel, Berichte aus Kliniken und Spitälern.

Aus der I. medizinischen Klinik des Herrn Hofrathes Prof. H. Nothnagel.

Ein Fall von Tumor der Hypophysis cerebri ohne Akromegalie.

Von Dr. Alfred Fröhlich.*

M.H. Ich möchte mir erlauben, Ihnen einen Fall zu demonstrieren, den ich in dem von Herrn Professor v. Frankl-Hochwart geleiteten Nerven-Ambulatorium der Klinik des Herrn Hofrathes Nothnagel zu beobachten Gelegenheit hatte und der mir in mancherlei Hinsicht Bemerkenswertes darzubieten scheint.

FIG. 5. Fröhlich's report of "A Case of Tumor of the Hypophysis without Acromegaly."

similar proved case a year earlier, but the popularity of the Viennese School was such that Fröhlich's, rather than Babinski's name was attached to the syndrome.*



FIG. 6. Jacob Erdheim, 1874-1937. (Photograph taken in Vienna, 1931.)

* It is interesting to note here that Fröhlich persuaded the Viennese neurosurgeon, von Eiselsberg, to operate on his original patient, and a cystic tumor of this type was found; but too late to save the child's vision. The patient, however, was still alive when Fröhlich had to leave Vienna for this country in 1939. (Fulton.²²)

The next major contribution to our knowledge of tumors of the pituitary gland was by Jacob Erdheim (Fig. 6), the pathologist of Vienna, who showed that the tumors most apt to produce Fröhlich's syndrome were suprasellar in position, teratomatous in character, and often distorted the hypothalamus, which could explain the obesity. Erdheim made many important contributions to the histology of the pituitary gland and its tumors, and was the first to identify a basophilic adenoma in 1933.²² It remained for Cushing to develop in 1909 the concept of hyperpituitary and hypopituitary states and his monograph "The Pituitary Body and Its Disorders" published in 1912¹⁴ is still a veritable mine of information, and a prize to be acquired in secondhand book stores. Cushing was the pioneer in brain surgery as Caldwell was in roentgenology; both were indefatigable, always alert, and never satisfied with things as they were, ever striving for something better.

PITUITARY TUMORS IN GENERAL

But what do we know about these varied pituitary tumors? We know that there are two main types, the craniopharyngiomas and the adenomas. The former are the congenital cysts arising from a remnant of Rathke's pouch, usually suprasellar in position, frequently (70 per cent) containing enough calcium for the roentgenologist to recognize them on the roentgenograms.⁴⁸ They are found mostly in children, usually give rise to a hypopituitary state of adiposity, dwarfism, and sexual infantilism, as described by Fröhlich, and cause blindness if not relieved by operation. They do not respond to roentgen irradiation in my experience.

The pituitary adenomas are of three main types, classified by their histopathological appearance as (a) chromophobe, (b) acidophil and (c) basophil. About 70 per cent of the 338 verified adenomas in Cushing's series were of the chromophobe type, 20 per cent were acidophilic and 10 per cent were mixed (d) chromophobe and acidophil

cells. The basophilic adenomas are rare. Only two with the syndrome which I shall discuss later were verified by autopsy in Cushing's series.

(a) The chromophobe cells are presumably the mother cells of the pituitary gland. They are nongranular, poorly staining cells and have no known secretion or function in the human. Adenomas formed by this type of cell, therefore, are nonsecretory, and cause symptoms only by compressing neighboring structures, such as the normal cells of the pituitary gland, the optic chiasm and, if they extend beyond the sella, the third ventricle, temporal lobe or hypothalamus. Due to compression of the normal acidophil and basophil cells, their *endocrine* symptoms are those of hypopituitarism, such as amenorrhea or impotence, sluggishness, sensitivity to cold, and changes in bodily characteristics such as thin fine hair, thin dry skin, lack of perspiration and scanty axillary and pubic hair. Such tumors are rarely seen before puberty so that growth is not affected. Most of these adenomas make themselves evident between thirty and forty-five years of age, but the diagnosis may not be made before ten or fifteen years have passed.

The *neighborhood* symptoms are chiefly those of pressure on the hypothalamus leading to obesity and somnolence, and those due to pressure on the optic chiasm or nerves with resultant failure of vision. The characteristic finding is a bitemporal visual field defect. Failing vision, with or without headaches, is the most common reason for this type of patient to seek medical advice. These tumors responded to irradiation in 80 per cent of our series, often with prolonged remissions of symptoms and improvement or restoration of vision. An index of the value of roentgen treatment is the table from Henderson's³⁶ follow-up of all of Cushing's 338 confirmed adenomas, which show a much higher freedom from recurrence five years after operation in those patients who had postoperative irradiation (Table 6a). About 17 to 20 per cent of the chromophobe adenomas are

cystic and do not respond well to irradiation alone, but postoperative irradiation is just as beneficial in this group, preventing or postponing recurrences, as in the solid adenomas.

(b) The acidophil adenomas are made up of coarsely granular cells which take the acid eosin stain well, and are actively secreting tumors. They occur only occasionally before growth has ceased,* but when they do, cause gigantism. More commonly they occur at thirty to forty years of age and acromegaly is the result. Rarely acromegaly is superimposed upon gigantism. In contrast to patients with chromophobe adenomas, these patients show the endocrine effects of *hyperpituitarism*, chiefly of the growth factor, which leads to gigantism in young persons or acromegaly in adults. Concurrently there is often an overproduction of other pituitary hormones such as the thyroid-stimulating one, certain gonadotropins and some as yet ill defined anti-insulin factor. The overgrowth is not limited to the skeleton, as many think, but involves all the viscera and probably all body tissues. Also in contrast to the *hypopituitary* state in patients with chromophobe tumors, these acromegalics have coarse abundant hair, thick skin with excessive perspiration, increased basal metabolic rate, excessive menstruation or increased libido et potentio, decreased sugar tolerance, sometimes with glycosuria, and marked mental disturbances. The acromegalic patient is apt to be obstreperous, cantankerous, and difficult to handle, in contrast to the patient with a chromophobe adenoma who is apt to be placid, acquiescent and cooperative. Less than half of the patients with acidophil adenomas suffer from visual failure, but headache is often the presenting or outstanding complaint. These patients often complain of "waves" of acromegalism with accession and recession of their symptoms for no apparent cause. (The patients with basophilic tumors also have recurrent "waves" of activity which are poorly understood.)

* Only 6 in Cushing's series of 75 patients.

The roentgen examination of the skull in the acromegalic group shows, in addition to the coarse, heavy, thickened bones, enlarged nasal accessory sinuses, enlarged mandible, and an enlarged pituitary fossa in 80 per cent of the cases. Twenty per cent of the acromegalics in our series had normal sellae in contrast to the chromophobe group where only 7 per cent had normal sellae and 93 per cent had enlarged "ballooned" pituitary fossae. Calcification in or around these adenomas is rarely seen but when present is probably due to hemorrhage or to necrosis in the tumor.

The effects of irradiation are difficult to assay in the acidophil group due to the "waves" of acromegalism, and due to the fact that spontaneous remissions are common. Not infrequently the acromegalic patient after some years of activity spontaneously changes from a *hyperpituitary* state to one of *hypoactivity*, but the acromegalic features do not regress. The headaches, often the most distressing symptom, were relieved by irradiation in 90 per cent of our patients, and we believe, although it is hard to prove, that the development of acromegaly (or gigantism) can be stopped by prompt and adequate irradiation. The most common causes of death in acromegalic patients, in order of frequency, are (1) diabetes, (2) heart failure, (3) hypertension and apoplexy, and (4) intracranial extension.

(d) The signs and symptoms in patients with "mixed" adenomas are usually the same in the beginning as those of acromegaly, but then the development of the classical acromegalic state stops and the patients present the more common features of hypopituitarism of the chromophobe type of adenoma. Cushing¹⁵ called this "fugitive acromegaly" and explained it by assuming that the chromophobe cells outgrew the acidophil cells and, by compressing them, stopped their function. The subsequent course of the signs and symptoms is that of the chromophobe adenomas.

PITUITARY BASOPHILISM

(c) To return to the basophil adenomas or pituitary basophilism, we find in this syndrome the most bizarre and complex signs and symptoms of polyglandular dyscrasia. This syndrome is characterized by:

1. A peculiar plethoric painful adiposity of the face, neck and trunk, sparing the extremities.
2. Cyanosis of the face, neck, hands, and feet.
3. Amenorrhea in the female; loss of libido et potentio in the male.
4. Hypertrichosis in the female with decrease in normal hair.
5. Muscular weakness, irritability, drowsiness or depression.
6. Changes in the skin, which is thin, dry, mottled and scaly, often with pigmentation; easy bruisability, slow healing, and facial acne.
7. Polyphagia, polydipsia and polyuria.
8. Osteoporosis of spine, skull and pelvis.
9. Glycosuria or decreased sugar tolerance.

Any of these signs or symptoms may be absent in an individual patient, or delayed in appearance, and no one symptom or group of symptoms is essential in the syndrome. Less frequent in occurrence and sometimes absent from the syndrome are:

10. Vascular hypertension, sometimes fluctuating.
11. Polycythemia of mild degree.
12. Low basal metabolic rate in the majority, occasionally normal or even elevated.
13. Cardiac enlargement, usually present at autopsy, probably a result of the hypertensive state.
14. Arteriosclerosis, generalized.
15. Nephrolithiasis.

Different authors emphasize various features of the syndrome, but all agree that the condition is a true syndrome, of variable degree and intensity as to its individual features, and of hotly debated and unproved etiology at present. Cushing attributed the entire syndrome to the basophil adenoma which has been found in

most but not all of the autopsied cases. He acknowledged the close similarity to the signs and symptoms in some patients who had adrenal cortical tumors, and stressed the part played by the overactive adrenal glands, but attributed the initial etiological stimulus to the basophil cells of the pituitary gland in all instances. The storm of discussion and criticism which I mentioned earlier chiefly concerned the explanation of the syndrome as of pituitary rather than adrenal origin, and did not apply to the clinical features of the syndrome. Those who were in a position to know or to understand the syndrome quickly took sides in the controversy, and the endocrine field became divided into two opposing camps, the Pituitary Basophil army and the Adrenocortical forces. (There were Big Guns and Heavy Artillery in both camps and active bombardments ensued.)

Before going into the various solutions suggested for this controversial point it might be profitable to take stock of our present knowledge of the pituitary gland as it may be affected in Cushing's syndrome.

PITUITARY-ADRENAL MECHANISMS

When Cushing first described the signs and symptoms of what he then termed "pituitary basophilism" the knowledge of the endocrinology of the pituitary gland was just undergoing a tremendous, yet somewhat vague, expansion. While it was generally recognized then that the pituitary elaborated hormones which stimulated a great number of other endocrine glands and some of which directly affected metabolic processes, their nature, source and exact mode of action remained to be determined, for the most part, during the next two decades.

Today we know that the anterior lobe of the pituitary gland secretes, among others, a hormone known as the adrenocorticotrophic hormone* which is thought to be formed by the basophilic cells.

* This moderately well characterized substance is known as ACTH for short.

Sensory stimuli acting through the central nervous system increase the secretion of the adrenocorticotrophic hormone and so does adrenalin. The adrenalin in turn arises from the adrenal medulla through stimulation via the sympathetic nervous system whenever the organism is put into a state of alarm. The adrenocorticotrophic hormone, carried to the adrenal cortex by the blood stream, profoundly affects the secretory cells of this vital gland. There is an immediate release of the cortical hormones and, if the stimulus is long continued, there follows a period of exhaustion; then an increase in the number of cells, a true hyperplasia, which is accompanied by an excessive secretion of adrenal cortical hormones. This series of physiological changes centering around both independent components of the adrenal gland constitutes a rather beautiful extension of the concepts of the late Walter Bradford Cannon, the eminent physiologist and early roentgen-ray pioneer, as to the important part the sympathetic system plays in the survival of the body in inclement environment. Fuller Albright¹ has pointed out the similarity of the endocrine disorders in Cushing's syndrome to those of the alarm reaction of Selye.⁵⁷

To date the adrenocorticotrophic hormone has not been shown to exert any metabolic effect on any known system in the absence of a responsive adrenal cortex. In the absence of the adrenocorticotrophic hormone adrenal cortical function appears to be able to carry on to a slight degree, but is unable to respond to an alarming situation by an increase in its secretory activity, —i.e. it is adequate for the organism under basal conditions but fatally incompetent under even the mildest of stresses, such as infection.

From this brief summary it should be obvious that there exists a rather delicately balanced mechanism for the maintenance of "homeostasis," to use Cannon's convenient term, in which both the anterior pituitary and the adrenal cortex play their part. The existence of a functional adenoma

in either of the glands will lead to a pathological increase in their secretory activity. A malignant condition, no longer subject to any regulatory action, will produce even more striking effects.

What are the effects of adrenal cortical secretions? At least three functional types of hormone are known to arise from the adrenal cortex:

(1) Those which by preserving the sodium and water for the organism regulate the state of hydration, blood volume and blood pressure. The "salt hormone," deficient in Addison's disease, is present in some excess in most cases of Cushing's syndrome. Desoxycorticosterone, synthesized in 1937 and commercially available for practical treatment, is an example of this type of adrenal hormone.

(2) Those closely related to the male sex hormones of the testes which contribute to secondary male sex characteristics and tend to enhance the formation of muscle tissue at the expense of carbohydrate and fat formation. The "N" hormone or androgens are deficient in eunuchism and excessive in masculinizing tumors of the adrenal but not much elevated in Cushing's syndrome, as a rule. Androsterone, closely related to testosterone, which is available for therapeutic use, is a representative androgen.*

(3) A group of hormones known as the corticoids or "S" hormones which counteract the androgens by diverting body tissue into the metabolic pool for the ultimate formation of carbohydrate and fat at the expense of muscle and bone matrix. They tend to increase liver glycogen, blood sugar and body fat, depleting the muscle mass and leading to osteoporosis. They also regulate certain of the blood elements, leading to the destruction of lymphoid tissue,^{21,24} decreasing circulating eosinophils and increasing the neutrophil count of the blood.^{24,37} The "S" hormone or corticoids are greatly increased in cases of Cushing's

syndrome, the urinary excretion being over ten times the normal, as a rule. Corticosterone and its derivatives are examples. None has been prepared in sufficient quantity for therapeutic use, but the whole extracts of adrenal cortex such as "cortin" contains these factors in variable amounts.

The relation of the adrenocorticotrophic hormone to the excretion of these factors in man has recently been clarified by work done on the medical wards of the Peter Bent Brigham Hospital by Thorn and his collaborators. They found that the administration of adrenocorticotrophic hormone to humans leads to nearly all of the metabolic changes which one might expect to obtain if all three cell types had been activated. Salt retention and corticoid-like activity were affected much more markedly than the production of androgens, a picture which closely simulated the findings in Cushing's syndrome, many of the metabolic changes of which were actually reproduced.²⁴

With this somewhat oversimplified description of established mechanisms in mind, the variety of findings in Cushing's syndrome should appear somewhat less irrational.

PATHOLOGICAL PHYSIOLOGY

A basophilic adenoma *per se*, in the absence of increased adrenal cortical activity, could not be expected to give rise to any of the metabolic changes that lead to the development of Cushing's syndrome. The syndrome may be present in the absence of demonstrable adrenal cortical changes, which is only the reflection of our inability to demonstrate functional changes at post-mortem. In fact, in rare cases such as the one reported by Freyberg *et al.*,²¹ atrophy of the adrenal cortices may be found. This would represent a state of complete adrenal cortical exhaustion following continued stimulation by adrenocorticotrophic hormone with a fulminating atrophy and death in an adrenal crisis with the anatomical findings of Cushing's syndrome still present elsewhere in the body.

* The 17-ketosteroids are breakdown products of the "N" hormones or androgens, and not necessarily of androgenic activity in this form.

Conversely, a basophilic adenoma need not necessarily be expected in every case of Cushing's syndrome since a primary adenoma of the adrenal cortex or a tumor of the primordial cells of the ovary such as an arrhenoblastoma may produce many of the characteristic changes.

Whether the initial stimulus to adrenal hyperplasia arises in the pituitary cells or in the cells of the adrenal cortex, the syndrome will still be characterized by the effects of the particular adrenal cortical hormones which are produced in excess. The syndrome will vary somewhat depending on which type of hormone predominates.

On the one hand, we have the adrenogenital syndrome in which excessive secretion of androgens leads to the characteristic increase in muscularity and male sex characteristics. The most marked cases represent primary adrenal tumors as a rule. On the other hand, we have true "Cushing's disease" in which excessive adrenocorticotrophic hormone production leads to increased corticoid secretion producing the generalized tendency to loss of protoplasm, fat formation and diabetes. Between these extremes extends a veritable spectrum of abnormalities comprising Cushing's syndrome.

The next major contribution to our knowledge of pituitary basophilism was that of Crooke¹² in the pituitary camp, who described hyalinization of the basophil cells in the anterior lobe of the pituitary gland in Cushing's syndrome, both with and without adrenal tumors and basophil adenomas. This was accepted by many as the common denominator of the syndrome, but was explained by others, e.g., Severinghaus,⁵⁸ as a result of the condition (degeneration of the basophil cells) rather than the cause. It is interesting to note, in this respect, that the cells of the basophil adenomas, when present, usually do not have the hyaline change which is found in the other basophil cells. Crooke's findings were substantiated by Thompson and Eisenhardt⁶³ who reviewed the 94

cases reported in the literature up to 1940. They personally studied sections of the pituitary glands in 63 of the cases and found Crooke's changes in all but 5 of them, and added that these 5 were not clinically satisfactory instances of the syndrome.

Albright, Parson and Bloomberg² characterized the syndrome as one of hyperadrenocorticism with respect to the "S" or sugar hormone of the adrenal cortex, and clearly differentiated the adrenogenital syndrome from Cushing's syndrome. They agreed with Kessel⁴⁰ who in 1936 suggested that it was logical to designate the entire syndrome as "Cushing's syndrome," but to call those with proved basophilic adenomas and without adrenal tumors "Cushing's disease." Albright elaborated three successive theories (1941, 1942 and 1943 theories) to explain the mechanism of production of the clinical and laboratory findings on the basis of adrenal cortical hyperactivity. Albright emphasized three factors which he thought must be present in this syndrome: (1) diabetes (decreased sugar tolerance) resistant to insulin; (2) muscular weakness (with low creatinine excretion as an index of decreased muscle mass), and (3) osteoporosis, especially of the spine, with normal serum phosphatase, hypercalciuria early in the disease, and often nephrolithiasis. The other manifestations, he wrote, are of secondary importance and not always present. His deductions were that hyperplasia of the adrenal cortex should be present in every case of Cushing's syndrome. If not demonstrated he would either doubt the diagnosis or doubt the histopathological report.

Kepler³⁹ agreed with Albright that the essential feature of the syndrome is hyperadrenocorticism. He admitted, however, that the basophil adenomas may be responsible for the initiation of the adrenal overactivity. He felt also that in those cases where no tumor or other abnormality of any endocrine gland could be demonstrated [12 such cases reported up to 1940: see Cluxton *et al.*¹⁰] there might still be

hyperactivity of the adrenals without histopathological evidence to confirm it. This constitutes the most acceptable view at present on the subject of the pathological physiology of Cushing's syndrome.

Many other theories as to the causation of Cushing's syndrome have been elaborated, but most of them revolve around either hyperfunction or dysfunction of either the pituitary gland or the adrenal cortex. The unusual bodily configuration (truncal obesity) has been explained as due to kyphosis and shortening of the spine due to the osteoporosis (Freyberg and Newburgh²⁷) and in part due to weakness of the abdominal muscles. These interesting suggestions fail to explain the truncal obesity in the patients without osteoporosis, kyphosis or muscular weakness.

Heinbecker³⁵ reported 5 autopsied cases of Cushing's syndrome, all 5 showing Crooke's changes in the pituitary basophil cells. In 4 he found degeneration of paraventricular hypothalamic nuclei. He reproduced changes similar to Cushing's syndrome in animals by injuries to the hypothalamic nuclei. His theory was that hyalinization of the basophil cells was the intermediate stage in Cushing's syndrome, and could be caused by adrenal cortical tumor, thymic tumor or atrophy of the hypothalamic nuclei, and that Cushing's syndrome was really one of *hypopituitarism*, explaining the basophil adenomas as attempts at compensation for loss of basophil cells. A more reasonable explanation of his findings would be that through hypothalamic injuries the sympathetic system was activated, exciting the adrenal *medulla* to overactivity, which in turn provoked the adrenocorticotrophic hormone production from the pituitary basophil cells and finally hyperactivity and then hyperplasia of the adrenal *cortex*, as outlined on page 9. Whether exhaustion of the basophil cells and subsequent Crooke's changes in them would lead to compensatory basophil hyperplasia and adenoma formation is a moot question, but none the less interesting and stimulating.

Whatever the cause may be, and it is safe to say that at the present time no single cause has been found, the syndrome is still a distinct and definite one, even though there are variations in some clinical features, discrepancies in the laboratory and autopsy findings, and no universal satisfactory method of treatment.

PATHOLOGIC CHANGES

Autopsy findings in 98 cases reviewed by Thompson and Eisenhardt⁶³ showed:

- 60 pituitary tumors
- 22 adrenal tumors
- 12 no endocrine tumor
- 3 thymic tumors
- 1 arrhenoblastoma

As noted above, the authors reviewed the slides on 65 pituitary sections. Nearly all of the pituitary tumors were of basophil cells, and all but 5 of the pituitary glands revealed Crooke's changes. Of the 22 adrenal tumors, 20 were in females. Eighteen of the 22 were operated on and all died in the postoperative period. At that time (before 1940) there was no satisfactory treatment for adrenal insufficiency. Such is now available and fairly well understood.^{64,65} It is worth stressing that these patients with Cushing's syndrome stand operation poorly, and are apt to die of uncontrollable infection after operation or injury. In the patients with large hyperfunctioning adrenal tumors, the opposite adrenal is likely to be atrophied or absent, so that removal of the tumor results in acute adrenal insufficiency⁵⁹. The causes of death in other patients have been intracranial hemorrhage, acute pulmonary edema, or pneumonia, and heart failure, often due to the hypertension. Other autopsy findings commonly present are: normal or enlarged thyroid glands; normal or atrophied parathyroid glands (with 2 exceptions); normal or infarcted or hyperplastic adrenals (rarely atrophied); normal or inactive gonads; atrophied or absent thymus (with a few striking exceptions); fatty infiltration of the liver, parathyroids and pancreas; generalized arteriosclerosis;

cardiac enlargement; chronic glomerulonephritis or progressive vascular renal disease, sometimes with small calculi; osteoporosis with normal bone marrow and delayed epiphyseal union in the cases involving children.

LABORATORY FINDINGS

The laboratory findings have not been constant or always consistent, but the majority show:

A. Urine:

1. Glycosuria (or decreased sugar tolerance with normal fasting blood sugar).
2. Albuminuria and casts in some patients.
3. Occasional hypercalciuria, often early in the disease.

B. Blood:

1. Normal or slight to moderate elevation of red blood cell count and hemoglobin.
2. Polymorphonuclear leukocytosis with lymphopenia* and eosinopenia.
3. Phosphorus low normal; calcium high normal.
4. Hematocrits and sedimentation rates normal (in absence of infection).
5. Phosphatase normal (late increase with improvement).
6. Electrolytes normal in some cases. Chloride often shows a fall with an increase in the carbon dioxide combining power and the presence of a moderate degree of alkalosis.
7. Cholesterol normal or elevated.

C. Hormonal assays:

1. Mild to moderate increases in 17-ketosteroid excretion. (This is diagnostically significant in comparison with the excessive excretion of these androgenic breakdown products and of androgens in the adrenogenital syndrome.)
2. Greatly increased excretion of corticosteroids.

(This is diagnostic of adrenal cortical overactivity and in conjunction with some of the signs and symptoms of Cushing's syndrome it is diagnostic of it. The diagnosis cannot be made in the presence of a normal urinary corticosteroid excretion.)

3. Estrogens normal.
4. Pregnandiol found in some cases.
5. Various androgens are often somewhat increased but do not reach the levels found in the adrenogenital syndrome.
6. Gonadotropins increased in some (early?) and low in others (late?).
7. The truly diagnostic assay of adrenocorticotrophic hormone has, as yet, not been satisfactorily carried out in the clinic.

D. Metabolism:

1. Basal metabolism rates normal or low in some, elevated in others.
2. Nitrogen excretion increased (negative nitrogen balance) in a few, normal in most.
3. Normal calcium excretion in most cases, increased in a few (early?).
4. Loss of calcium and phosphorus from gastrointestinal tract, not improved by giving Vitamin D.
5. Good utilization and retention of intravenous calcium.
6. Urinary creatinine excretion low.

ROENTGEN FINDINGS

The roentgen rays are important in the diagnosis of the syndrome as well as in therapy (see below). Diagnostic roentgen examinations should include the skull, the spine and pelvis, chest and urinary tract. The majority, but by no means all, of the patients have a true osteoporosis as defined by Albright.† This is either limited to or more marked in the skull, spine, pelvis and ribs and may spare the extremities.

* Modern studies, by de la Balze *et al.*²⁰ have shown that the adrenocortical secretions are antagonistic to lymphatic tissue elsewhere in the body. Thus in Addison's disease we find a relative lymphocytosis, and excess lymphatic tissue in the body. With the opposite state of hyperadrenocorticism the usual finding is lymphopenia, and decreased lymphatic tissues. The 3 cases reported as associated with thymic tumors and Freyberg's case of atrophied adrenals and hypertrophied thymus²¹ could be explained by complete exhaustion of the adrenal cortex as noted above.

† Albright defines "osteoporosis" as a condition due to the inability of the organism to form and lay down the protein matrix of bone, quite different from osteomalacia (inability to deposit calcium in the matrix) and osteitis fibrosa cystica (excessive loss of calcium from the bone). By this definition, borne out by many experiments, the osteoporosis of Cushing's disease is therefore not due to excessive activity of the parathyroid glands, as Cushing at first believed.

There may be spontaneous fractures, particularly of the ribs and the vertebral bodies. Some patients have dense end-plates on the vertebral bodies. Mild degrees of osteoporosis may escape detection, as there is no accurate measure of calcium content of bone by roentgen methods. A dorsal kyphosis is often the result of collapsed vertebrae. In young patients there is usually delayed epiphyseal growth.

The skull may show the fine diffuse granular mottling of osteoporosis but no localized changes and no evidence of increased intracranial pressure. The sella turcica should be normal in size and shape. (2 exceptions (Fuller and Russell³⁰)). The lamina dura is intact around the teeth, in contrast to the osteitis fibrosa cystica of hyperparathyroidism, where it is absent.

The ribs frequently are fractured, often with excess callus around them, even though the history of definite injury may be absent. We have been unable to confirm Sussman and Copleman's⁶⁰ findings of broadening of the anterior ends of the ribs on roentgen examination with excessive callus found in this area at autopsy. (All 4 of their patients with this finding suffered from adrenal carcinoma.) The lungs and mediastinum should be studied roentgenologically in every case to rule out a tumor or metastasis. The heart will be found to be moderately enlarged in most cases, particularly those of long duration and those with hypertension.

Every patient should have roentgen examination of the genitourinary tract as part of the original investigation, and this should include films of the entire abdomen, as well as intravenous or retrograde pyelograms. A definite tumor mass may be demonstrable as in our Case IV, or the roentgenograms may reveal displacement of one kidney or elevation of one diaphragm, or both together. Perirenal air insufflation is useful in practiced hands, but the diagnostic findings in general are hardly worth the time and trouble required. Exploration of both adrenal areas has been done in many patients in preference to Carelli's

procedure. Not infrequently the roentgenograms will reveal small renal calculi, a finding which has not been stressed in the literature.

The frequency of gallstones in patients with this syndrome is unknown, as it is rarely mentioned in the protocols, but we would expect it to be high. Our Case II has gallstones at the age of thirty, and gallstones were found at autopsy in Case III.

CASE REPORTS

CASE I. Earl F. (previously reported, Case II in reference 15).

A dentist, aged thirty, was admitted to the Peter Bent Brigham Hospital August 11, 1930, complaining of painful obesity, loss of strength, irritability, polyuria and polyphagia. Family and past history were unessential, patient being married with two children. Present illness began five years before admission, when he noticed he was growing round shouldered and stout, having gained 60 pounds. He dieted and lost weight but became easily fatigued, unable to concentrate, irritable, then depressed. Fat deposits appeared symmetrically on the head, neck and face; then the skin of the face became tense and cyanotic. Eight months before admission excessive thirst, weakness and impotence developed. Seven months before admission glycosuria was discovered.

Physical examination showed a round-shouldered man, appearing older than his stated age. The abdomen was paunchy, the face, neck and trunk were obese, but the extremities by contrast appeared thin. The face was florid and dusky in hue, with tender fatty deposits covered with glistening red skin (Fig. 7). There were numerous purplish striae in the groins and over the abdomen and thighs. The skin over the extremities was pigmented and scaly. Laboratory findings revealed a red blood cell count of 4,800,000; white blood cell count of 16,700; hemoglobin 90 to 100 per cent; metabolic rate minus 10 per cent; blood pressure 170 systolic. The urine contained sugar two plus and excess nitrogen, termed "azoturia" by Woodyatt who had studied the patient thoroughly. Blood lipids were increased. Roentgenograms revealed a sella turcica normal in size and shape. No osteoporosis could be demonstrated in the skull, spine or pelvis.

His course, while undergoing elaborate investigation, was steadily retrogressive and he

soon became bedfast, with marked loss of strength, increased pain in the face and hips. A carbuncle developed over the sacrum and did not respond to therapy. At this point, October 14, 1930, a series of four daily roentgen treatments was given to the pituitary region, totalling about 800 r to each temporal area (measured in air). Immediate improvement followed and he was discharged two days after the irradiation was completed. He continued to im-

on February 21, 1935, from a spontaneous intrapontine hemorrhage. The body was exhumed after burial at the request of Dr. Cushing, and a postmortem examination was made on March 6, 1935. The pituitary body weighed 1.28 gm. Microscopical examination showed a large basophilic adenoma and the basophilic cells in the anterior lobe showed Crooke's changes. The postmortem showed a slight degree of arteriosclerosis, some skeletal decalcifi-



FIG. 7. Case 1, Earl F. before roentgen therapy (July 11, 1930) and after roentgen therapy (September 12, 1931).

prove gradually, and was eventually able to return to work. His blood pressure fell to 134/86, the weight decreased, and the glycosuria, polydipsia and polyphagia disappeared.

In spite of subsequent irradiation (1) in February, 1934, at the Presbyterian Hospital in Chicago, Illinois, with eight treatments to each temporal region over a period of six months totalling 2,100 r, (2) September, 1934, at Saint Anthony's Hospital in Rockford, Illinois, with 400 r to each temporal region, and (3) December, 1934, at the New Haven Hospital, New Haven, Connecticut, with 400 r to each temporal region, mild symptoms continued. However, he was able to work until he died suddenly

cation, and grossly normal appearing adrenal glands.

Discussion. The immediate response following roentgen therapy of only a moderate amount to the pituitary region was striking and dramatic. Whether it was due to the irradiation or not is another question. Also whether a more prolonged or permanent improvement would have followed repeated or more intensive irradiation as recommended by Freyberg *et al.*²⁵ is open to question. All of us are apt to fall into the error (probably a form of wishful

thinking) of reasoning that if a certain dose of irradiation gives a certain percentage of good results, an increased dose should give increasingly better results. Unfortunately this is not true, but further experience may tell us whether there is an optimum dose for this and other endocrine tumors, or whether there is a maximum dose, beyond which we do harm rather than good. Certainly this patient did not receive nearly as much irradiation, nor as persistent treatment at first as did the next patient who had a much better result.

CASE II. Alice D. (previously reported as Case I4, reference 16).

A fifteen year old girl was admitted to the

years of age. Her weight had increased as follows: twelve years old, 103 pounds; thirteen years old, 122 pounds; fourteen years old, 170 pounds.

Her immediate illness began with a convulsion followed by unconsciousness in December, 1931, followed by a second and similar attack February 29, 1932. After the second convulsion, sugar was found in her urine by Dr. Arthur Cushing of Brookline, who referred her to this hospital.

Physical examination showed a cooperative but lethargic girl, complaining of headaches and backache. Her weight had been reduced by diet to 132 pounds. She was round-shouldered, with adiposity of the face, neck and trunk, but not of the extremities. Her face was dusky red and plethoric, with coarse dark hair on her upper lip, cheeks and chin (Fig. 8). Her skin was dry, dusky and scaly, with cyanosis of hands and feet. There were purple striae distensae over the abdomen, shoulders and thighs, and in the groins. The clitoris was not enlarged.

Laboratory examinations revealed a blood pressure of 140/110, basal metabolic rate of minus 22 to minus 33 per cent, red blood cell count 4,880,000, white blood cell count 9,400, with 87 per cent polymorphonuclears and 13 per cent lymphocytes; hemoglobin 80 per cent (S), a low sugar tolerance with alimentary glycosuria, total proteins 5.4 gm., blood cholesterol 173 mg., nonprotein nitrogen 30.7 mg. per cent, blood calcium 12.1 to 10.0 mg. per 100 cc. Special studies by Dr. Aub showed her to be in nitrogen balance, but in negative calcium balance with an excessive urinary excretion of calcium.

Roentgenographic examinations showed a diffuse osteoporosis, especially of the skull and spine, with compression fractures of several vertebrae. The sella turcica was normal in size and shape. The heart was enlarged. Roentgen treatments were given in eight series of four treatments each, directed through the temporal portals at the sella, as follows:

April 21-25, 1932	4 treatments about 700 r X 2
June 2-6, 1932	4 treatments about 700 r X 2
Aug. 1-4, 1932	4 treatments about 750 r X 2
Nov. 1-4, 1932	4 treatments about 750 r X 2
Mar. 1-4, 1933	4 treatments about 750 r X 2
Nov. 6-9, 1933	4 treatments about 750 r X 2
Jan. 10-13, 1934	4 treatments about 750 r X 2
Mar. 13-16, 1934	4 treatments about 750 r X 2

There was slow and gradual improvement,



FIG. 8. Case II, Alice D., before roentgen therapy, April, 1932.

Peter Bent Brigham Hospital on March 29, 1932, with the complaint of an abscess near the rectum, which was found to be an infected pilonidal sinus.

The family history was unimportant. Her past history revealed an appendectomy at the age of eight, followed by an increase in appetite and gain in weight. Menses began at ten years but ceased abruptly in April, 1930, at thirteen

although the patient continued to gain weight to August, 1932. The first improvement noted was a change in disposition to a more alert and interested state, and a decrease in backache. Next, the abnormal hair on face, lips and chin began to diminish noticeably by August, 1932. By September her blood pressure was appreciably lowered; in October it was noted that the striae had lost their purple color and in February, 1933, menstruation returned and has been normal and regular since.

The patient has reported regularly for observation and in 1942, ten years after we first made the diagnosis, she was admitted to the hospital for a series of metabolic tests and measurements, all of which were within normal limits. She graduated from high school and started work as a secretary in 1936, was married in 1944, became pregnant in February, 1947, and on November 22, 1947, was delivered of a 5 pound, 14 ounce baby girl by Caesarian section (Fig. 9).

Complete studies in 1947 revealed her to be normal in all respects with three exceptions: (a) there still remained slight upper dorsal kyphosis, probably a relic of the previous osteoporosis (Fig. 10), (b) numerous small gallstones were discovered by roentgen examination, but are causing no recognizable symptoms, and (c) definite skin atrophy, depigmentation, scarring and telangiectases were present in both temporal areas where the irradiation was given.

Discussion. We still cannot call this a "cured" case of pituitary basophilism, but the patient has certainly ceased having the signs and symptoms of the disease. Her improvement followed irradiation of the pituitary region only, with no other form of therapy being given. The amount of irradiation may have been excessive, and she now has skin atrophy and telangiectases in both temporal regions; but if the improvement was due to the irradiation the local damage is but a small price to pay. It might be noted here that Case v, M. G., also has beginning radiodermatitis in each temporal area, with pigmentation and small telangiectases, following four series of treatments (*vide infra*). It seems quite probable that these patients with thin, easily bruisable and easily infected skin may have an increased skin sensitivity to irradiation.



FIG. 9. Case II, Alice D., and baby daughter sixteen years later; May, 1948.

CASE III. Miss P. (previously reported as Case 14, reference 17).

The patient, aged thirty-three, was admitted to the Peter Bent Brigham Hospital on October 24, 1932, for study and treatment after a thirteen year history of intermittent and variable polyglandular abnormalities. Her immediate difficulty was amenorrhea for fifteen months, and increased hair on her face.

Her past history revealed that her menses began at thirteen years, and were regular until cessation for twenty months at the age of twenty years. Excess hair on her face was first noted at twenty years of age, improving after the menses returned, but recurring at the age of twenty-five, and requiring a daily shave thereafter. She had been treated by several different physicians with endocrine preparations, with definite but temporary improvement. Eleven years ago there was a marked gain in weight, with the appearance of purplish striae in axillary, inguinal, breast and upper thigh regions. There had been a marked change in her dispo-

sition from a friendly and affable person to a sensitive, highstrung and irritable one. Four months before admission, her face and neck became puffy and swollen, and there was the onset of polyphagia, polydipsia, and polyuria. She also complained of headaches. Physical examination revealed a moon-faced young woman, with a fat neck and striae as noted above. Her skin was dry, with purplish-brown pigmen-

tation, but a high nitrogen output (negative nitrogen balance). The Aschheim-Zondek test was negative.

Roentgen examinations showed an indistinct sella turcica but no enlargement or distortion. There was a diffuse osteoporosis of mild degree and several small renal calculi were demonstrated by roentgenograms in each kidney.

Roentgen therapy was given to the pituitary



FIG. 10. Case 11. Lumbar spine before (October, 1932) and after (April 1, 1935) roentgen therapy to pituitary area. Note pathological fractures of T12, L1 and L4, also recalcification with clinical improvement.

tion on the lower legs. There were several ecchymoses, and a history of easy bruisability of the skin (see photographs in reference 17).

Laboratory findings included a blood pressure of 220/170, traces of albumin and sugar in the urine, low sugar tolerance, red blood cell count 4,600,000; hemoglobin 75 per cent; white blood cell count 7,600; basal metabolic rate minus 10 per cent; blood calcium 10.8 mg. per 100 cc.; blood cholesterol, 192; nonprotein nitrogen 47, fasting blood sugar 99 mg. per 100 cc. Metabolic studies by Dr. Aub revealed normal blood calcium and phosphorus, normal phosphatase, normal fecal calcium and phos-

phorus, but a high nitrogen output (negative nitrogen balance). The Aschheim-Zondek test was negative. Roentgen examinations showed an indistinct sella turcica but no enlargement or distortion. There was a diffuse osteoporosis of mild degree and several small renal calculi were demonstrated by roentgenograms in each kidney. Roentgen therapy was given to the pituitary

Discussion. Only three weeks elapsed

between roentgen treatment and death with no evidence of subjective improvement. Case I showed clinical improvement two days after irradiation was completed, but Case II showed no improvement for two months. There was no appreciable histopathological difference between this adenoma and others of the series, which could be ascribed to the irradiation. Sudden death is not uncommon in this syndrome, at times in what seems to be a hypertensive crisis, in others from heart failure and pulmonary edema. There was no really adequate cause found at postmortem for the sudden death.

CASE IV. Louise B. (not previously reported. S57086).

This thirty year old married Italian girl was admitted to the Peter Bent Brigham Hospital on March 9, 1938, complaining of sleepiness and blurred vision. Her family history was unimportant.

Her menses began at the age of fourteen, and there was a steady increase in weight from that time. At sixteen years excess hair was noted on the face, and at eighteen years there was increased hairiness on her body. Her weights were as follows: sixteen years, 140 pounds; twenty-one years, 180 pounds; thirty years, 200 pounds. In 1934-1935 there was an eighteen month period of amenorrhea, then two years of regular periods, with amenorrhea again after December, 1937. She had been married nine years with no pregnancy.

Her present acute illness began three weeks before admission with a sore throat, sweating, headache, sleeplessness, easy fatigue and blurred vision. Polydipsia and polyuria were also present. Libido disappeared two weeks before admission.

On physical examination the patient was found to be restless, irritable, and uncooperative. She was 5 feet, 4 inches tall, weighing 200 pounds with a tremendous torso, heavy features, and coarse dark hair on cheeks, chin, lip, chest and abdomen (Fig. 11). There was slight bilateral exophthalmos. Her blood pressure varied from 200/110 to 170/110 but it fell to 140/80 on bed rest. There was slight cyanosis and acne of the face. The clitoris was markedly enlarged. The extremities were well muscled but slender.

Laboratory findings included: Red blood cell



FIG. 11. Case IV. Louise B. Hirsutism and obesity in adrenogenital syndrome, not true Cushing's disease.

count 4,620,000, white blood cell count 11,000 to 26,000 (polymorphonuclears 65 to 90 per cent). Two plus sugar was found in the urine at times, negative at other times. The Aschheim-Zondek test was negative. Basal metabolic rate was plus 50 per cent. Hinton test was negative. Blood studies revealed calcium of 8.2 mg. per 100 cc.; phosphorus was 3.8 mg. per 100 cc.; cholesterol 208-131 mg. per 100 cc.; sodium 295 mg. per 100 cc. The androgens excreted in the urine were excessive, varying from 480 to 1,260 international units, compared to a normal of 50 units in twenty-four hours.

Roentgenographic examination revealed a large mass in the left flank, displacing the left kidney downward and the left diaphragm upward—interpreted as a large adrenal tumor. There was no osteoporosis.

Operation was performed March 18, 1938 by Dr. W. C. Quinby. A large tumor of the left adrenal gland weighing 600 grams was found and removed, but the tumor had metastasized, and her course was rapidly retrogressive, with death ensuing on the forty-fourth hospital day.

At autopsy there were metastases to the liver,

lung and retroperitoneal space. The ovaries were normal. The pituitary gland contained a minute chromophobe adenoma, and there were Crooke's changes in the basophil cells. The pars nervosa was invaded by basophil cells.

Bio-assay of portions of the tumor showed an excessive androgen content.

Discussion. This is a classical case of the adrenogenital syndrome, sharing many signs and symptoms and often confused with Cushing's disease. The differential points are obvious: first, the excessive androgen excretion in the twenty-four hour specimen of urine; second, the marked enlargement of the clitoris; third, other signs of virilism, such as bodily hirsuties; and fourth, the lack of muscular weakness. It is interesting to note that Crooke's changes were evident in the pituitary basophil cells.

CASE V. Mary G. (previously reported, reference 19).

This fifteen year old Italian girl was admitted to the Peter Bent Brigham Hospital December 26, 1941, for metabolic studies. The chief complaints which brought her to the Out Patient Department were a rapid gain in weight, pain in the back and cessation of menstrual periods for one year. The patient had always been thin and underweight until her menses began at twelve years, when there was an increase in appetite and gain in weight. She had had mild facial acne since the onset of menstruation and the acne became worse during the menstrual period. At thirteen years she noticed increasing hairiness and redness of her face, headaches and backaches, which have persisted since then. There was a gain in weight from 108 pounds in June, 1941, to 148 pounds in December, 1941. Her height was 4 feet 11 inches.

At physical examination she was found to be an obese, shy, disturbed and unhappy girl, with a round plethoric face and numerous spots of acne on face and chin (Fig. 12). There was excess hair, coarse and dark, on cheeks, upper lip and chin. Pinkish striae were found on thighs and buttocks. No masses could be palpated in the obese abdomen. Hands and feet were small. The clitoris was hypertrophied. Visual fields were normal.

Laboratory findings were as follows: Blood pressure 145/80; red blood cell count 6,150,000;

hemoglobin 15.2; hematocrit 47 per cent; white blood cell count 10,000 to 21,000 with 90 per cent polymorphonuclears, 9 per cent lymphocytes and 1 per cent eosinophils; smear normal; nonprotein nitrogen 38 mg. per cent, total protein 8.0 gm. (albumin 5.4, globulin 2.6); blood cholesterol 262 to 320 mg. per 100 cc.; blood calcium, phosphorus, chlorides and sodium essentially normal.

Roentgen examination showed a diffuse mottled osteoporosis of skull, spine and pelvis. The sella was normal in size and shape. The lungs were clear, the heart slightly enlarged. Intravenous urograms were normal and there was no evidence of adrenal or pelvic mass.

Therapy. Attempts to influence the disease were made by administration of (a) testosterone propionate, (b) diethyl stilbestrol, (c) roentgen therapy, (d) methyl testosterone, (e) testosterone—and further roentgen therapy in that order. The results may be summarized as follows: The patient was restored to a positive nitrogen balance during the administration of testosterone propionate and methyl testosterone, but there was no improvement in her general clinical condition. Stilbestrol likewise failed to affect her condition beneficially (see reference 19 for details).

Roentgen therapy was given as follows:

July, 1942 8 treatments 1200 r × 2

Feb., 1943 8 treatments 1040 r × 2

July, 1943 8 treatments 1040 r × 2

Coincident with and subsequent to the first roentgen treatments, signs of improvement occurred. Her ravenous appetite decreased; the acne and hirsutism improved considerably. There was a loss of weight from 199 pounds to 162 pounds, and a decrease in the cyanosis. Her menses returned in March, 1943. In April, 1943, she was again admitted to the metabolic ward and studies were made after oral methyl testosterone and testosterone propionate. There was a worsening of her outward signs of excessive maleness, i.e. increasing acne, hirsutism, cyanosis and gain in weight, with subsequent improvement after cessation of androgenic therapy and the final series of roentgen treatments.

She has continued to improve without further therapy, and at the present time (August 1, 1948) seems to be normal in all respects, seven years after first being seen at this hospital (Fig. 13). She is alert and cooperative; she weighs 144 pounds, and has lost her cyanosis, plethora and acne. She works long hours as a practical nurse,

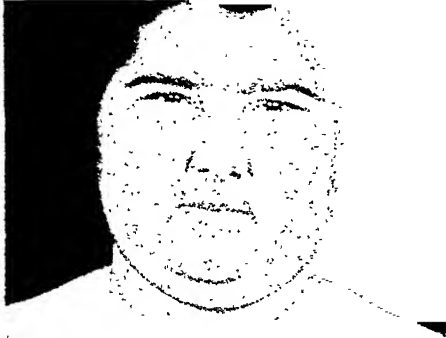


FIG. 12. Case v, Mary G. Before roentgen therapy (April 16, 1942).

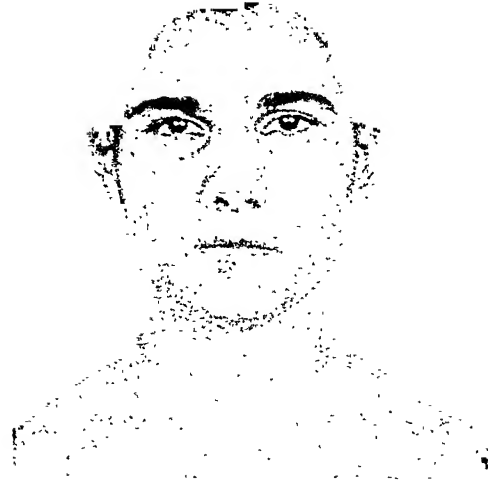


FIG. 13. Case v, Mary G. After roentgen therapy to pituitary region (April 17, 1946).



FIG. 14. Case vi, Walter S. Before roentgen therapy (April 30, 1947).

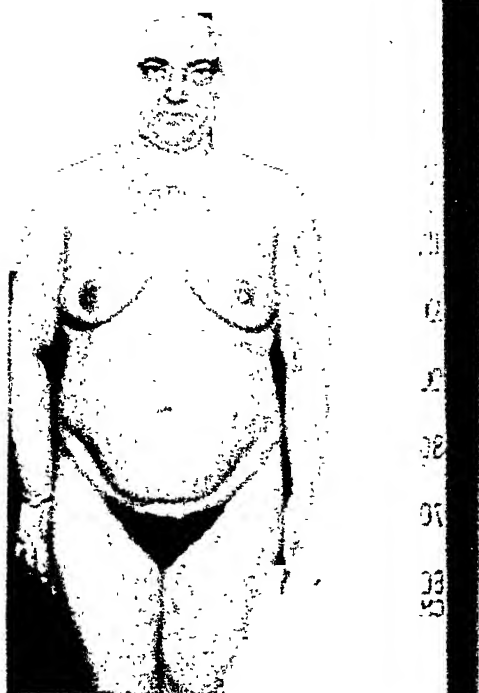


FIG. 16. Case vii, Loretta D. Before roentgen therapy to pituitary area (January, 1948).

having gone through a strenuous period of training in a small hospital near Boston. The hirsutism is still present and she finds it necessary to shave about three times a week. As noted above, there are areas of brownish pigmentation and beginning telangiectasia in each temporal area where the irradiation was given.

Discussion. This is an excellent clinical result of seven years' duration, in a classical case of Cushing's syndrome. The credit for this therapeutic improvement appears difficult to allot at first sight, as the patient received not only irradiation to the pituitary region but also testosterone and stilbestrol before irradiation, and testosterone subsequently. In spite of the metabolic changes induced by the hormone therapy, there was no improvement in the signs or symptoms of her disease until roentgen therapy was given. After definite improvement had occurred, her condition became worse when testosterone was again administered, then improved and continued to improve after cessation of androgen therapy and the final series of roentgen treatments. We feel that the credit for her improvement should be given to irradiation.

CASE VI. Walter S. (not reported previously. Cushing V. A. Hospital No. R2321).*

This unmarried veteran, aged twenty-seven, was referred to the department of Radiology from the Cushing Veterans Administration Hospital with a diagnosis of Cushing's syndrome, for irradiation of the pituitary region. His history, in brief, is as follows: He was admitted on March 3, 1947, to the Cushing Veterans Administration Hospital (Framingham, Mass.) because of a persistent dermatitis of the hands, wrists and right leg, and for evaluation of asymptomatic hypertension. The onset of the former came while he was on Guadalcanal in 1943; it had remained essentially unchanged except for transient periods of improvement. Over the two and one-half year span preceding admission, he had noted a gradual change in body configuration, with enlargement of the abdomen and increasing fullness of the face. These changes were associated with the insidious and

successive appearance of generalized weakness, easy bruisability of the skin, decreased perspiration, visual disturbances, skeletal pain, decreased libido, and headache. An elevated blood pressure had been detected on routine physical examination some seventeen months prior to admission. He gave a history of renal colic and the passage of stones from the left and right sides in 1944 and 1945 respectively. Physical examination showed a man 61 inches in height, weighing 124 pounds, with a round red face (Fig. 14) and a small globular body. Temperature, pulse and respirations were normal. Blood pressure was 150/110 to 190/145. The skin on the hands was thin, dry, red and cracked, and lipomatous deposits were apparent in the neck. The thyroid was barely palpable. Visual fields were normal but considerable arteriosclerosis was found in the retinal vessels.

Laboratory findings included the following: red blood cell count 5,205,000; hemoglobin 15.0 Gm.; white blood cell count 9,800 to 14,350, with 58 per cent polymorphonuclears, 41 per cent lymphocytes, and 1 per cent eosinophils; urine contained occasional albumin but no sugar. The glucose tolerance test revealed a normal curve with no glycosuria. Serological findings were negative. Nonprotein nitrogen 40 mg., cholesterol 200 mg. per 100 cc., total protein 8.5 (albumin 4.8, globulin 3.7); phenol-sulfonphthalein test 50 per cent in two hours. The glucose-insulin test was abnormal, but on repetition showed a normal flat curve. The Sulzkoitch test was two plus, and again two plus after three days of low calcium diet. Blood calcium was 9.5 mg., phosphorus 2.7 mg. per 100 cc.; phosphatase 5.0 Bodansky units. Basal metabolic rate was minus 14, minus 21 per cent. CO₂ was 60 to 78 volumes per cent (26.8–34.8 milliequivalents per liter). Cortin in the urine was 1.8 mg. in twenty-four hours, and repeated on a low protein diet was 1.4 mg. in twenty-four hours.* 17-ketosteroids averaged 9.7 mg. in twenty-four hours; chlorides 90.6 mg.

Roentgenograms of the chest showed old fractures of the third and sixth ribs on the left with callus (Fig. 15). The heart was not en-

* I am indebted to Dr. Maurice B. Strauss and Dr. Carmer Hadley for the details on this patient.

* Tests done by Dr. W. H. Daughaday who wrote: "The value of 1.8 mg. of cortin-like material is slightly elevated by our method (normal 1.0–1.6) but definitely lower than those cases of Cushing's syndrome who did show abnormalities of carbohydrate metabolism. We did not make sufficient observations to determine whether the fall to 1.4 mg. on a low protein diet was significant but it suggests the influence of dietary protein on cortin excretion as suggested by Dr. N. B. Talbot."



FIG. 15. Case VI. Osteoporosis of spine, numerous spontaneous rib fractures, and bilateral renal calculi.

larged and the lungs were clear. The skull showed osteoporosis and a normal sella turcica. The spine was osteoporotic but with no collapse of the vertebrae. A roentgenogram of the abdomen showed a small calculus in the left kidney. Films of the extremities and intravenous urograms were normal.

Put on the rice diet for one week, the patient's blood pressure fell to 110/85, but he complained of headaches and marked weakness and the diet was discontinued. Roentgen treatments of 900 r \times 2 were given at the Peter Bent Brigham Hospital from April 22 to 30, 1947, with no effect noted in the subsequent seven months. The patient was then readmitted to the Cushing Veterans Administration Hospital with definite evidence of progression of his disease, but still without disturbance of carbohydrate metabolism. Re-examination by roentgen ray revealed spontaneous fracture of the ninth thoracic vertebra.

In November, 1947, the patient was transferred to the Massachusetts General Hospital for perirenal air insufflation and possible exploration of both adrenal areas. Blood and urine chemical and metabolic determinations were essentially unchanged from previous studies.

During his preoperative period he suffered a compression fracture of the first lumbar vertebra. Perirenal air insufflation showed a normal-sized right adrenal and an enlarged left adrenal. In December, 1947, approximately 40 per cent of an enlarged but histologically normal left adrenal was excised at operation. The postoperative course was uneventful except for the passage of a small calcium oxalate calculus.

One month later 60 per cent of the right adrenal was excised. The gland appeared normal grossly but microscopically was seen to be hyperplastic. The postoperative period was stormy and characterized by weakness, nausea, vomiting, weight loss, a fall in blood pressure from 125-130/100-110 to 80/50, and the onset of generalized brownish pigmentation accentuated in the palms, antecubital spaces, axillae, and the gluteal folds. Vigorous supportive therapy was necessary during this period, including the use of aqueous adrenal cortical extract, lipoadrenal extract and whole blood transfusions. Four weeks after operation it was noted that his face was less plethoric and that his blood chemistry was normal. Late in his convalescence he passed another ureteral calculus.

In April, 1948, he was readmitted to the Cushing Veterans Administration Hospital where several serum sodium determinations were normal. In August, 1948, his condition was as follows: weight 85½ pounds, height 60 inches, blood pressure 95-105/65-80, pulse varying from 100 to 115. The pigmentation mentioned above was still present. The heart was normal in size and shape as shown roentgenologically. His eosinophil count was still low and his bones still osteoporotic. He was well enough to be home, but was receiving 5 mg. of desoxycorticosterone intramuscularly daily. The Cushing's syndrome seems to have been ameliorated but by no means cured by the partial adrenalectomies.

Discussion. This patient was deliberately given a relatively small dose of roentgen irradiation to his pituitary region (900 r \times 2) in an attempt to find out if a good clinical result could be obtained at this level of dosage, not repeated. There was neither subjective nor objective evidence of improvement. Instead of giving a second and larger dose of irradiation to the pituitary gland, or a comparable dose to the adrenal areas, he was subjected to partial adrenal-

ectomy, with amelioration of his symptoms as noted above. The result in this patient may be compared with that in the next patient (Case VII) in whom a larger dose was given (1500 rX3). The comparison may be unfair as Case VII is a female, and our best and most lasting improvements have been in females. The underlying disease may be appreciably different in the two sexes in addition to the difference in its outward manifestations.

CASE VII. Loretta D. (7A439), aged thirty-seven, mother of two children, entered the Peter Bent Brigham Hospital on December 31, 1947, because of hypertension and diabetes. The patient had been well until her last pregnancy four years before admission when an elevated blood pressure was noted. During the six months prior to admission, she gained 30 pounds in weight, with swelling of the face, neck, trunk, arms and thighs. There was excessive growth of facial hair, and she noted acne of the face and neck, headaches, weakness, and for three months amenorrhea. The physician she consulted found high-grade hypertension and glycosuria and referred her to this hospital for diagnosis and treatment. The past history was noncontributory. There was no family history of hypertension, tumor, diabetes or other endocrine disease.

On examination, the patient was obese, with acne of the face and trunk, excessive facial hair, and purple striae on the abdomen and limbs (Fig. 16). The face had a dusky, plethoric complexion. Blood pressure was 240/130 mm. Hg. There was tenderness of the mid-thoracic spine. The heart and lungs were unremarkable; the abdomen was obese. The visual fields and neurological examination were normal.

The blood Hinton test was negative. The hematocrit was 47 per cent; the white blood cell count 15,000, with 81 per cent neutrophils, 13 per cent lymphocytes and 6 per cent monocytes. The urine contained 1 plus protein and 1 plus sugar. The blood urea nitrogen, total protein, calcium, phosphorus, and alkaline phosphatase were within normal limits. The fasting blood sugar was 197 mg. per 100 cc., the CO₂ combining power 29.9 mm/l, serum chloride 94 milliequivalents per liter, and serum sodium 142.2 milliequivalents per liter. Phenolsulfonphthalein dye excretion was 45 per cent at fifteen minutes and 90 per cent at 120 minutes.

Basal metabolic rate was plus 2 per cent. Stools normal.

Roentgenography revealed no abnormality of the skull or chest and no osteoporosis of the spine. Intravenous urograms revealed no evidence of adrenal tumor. The electrocardiogram was normal.

Extensive metabolic studies revealed an abnormally high urinary excretion of 11-oxysteroids, 0.65 mg. in twenty-four hours, and slightly elevated 17-ketosteroids, 22.5 mg. in twenty-four hours. Intravenous glucose tolerance test showed a typical diabetic curve, and the insulin tolerance test demonstrated a relatively insulin resistant diabetes mellitus. Fast-

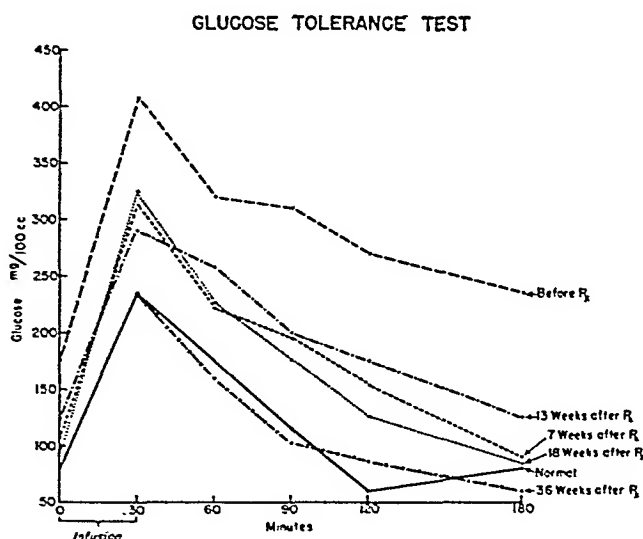


FIG. 17. Case VII. Glucose tolerance curves showing gradual return to normal after irradiation of the pituitary region.

ing blood eosinophil count was 4 per cu. mm. (normal 100–250 per cu. mm.), indicating excessive adrenocortical function. The adrenocorticotrophic hormone test produced a further drop in the partially exhausted reserves of lymphocytes and eosinophils, and the uric acid/creatinine ratio was high and rose only from 0.83 to 1.15.

On the basis of these studies, the diagnosis of Cushing's disease was made and the patient was given fifteen daily roentgen treatments, from January 12 to 28, 1948, to the pituitary area, through three portals, for a total dose of 1,500 rX3. Before discharge from the hospital on February 1, 1948, the fasting blood sugar had fallen to 117 mg. per 100 cc. During the subsequent eight months, up to the present writing, the patient has continued to improve with gradual loss of the abnormal facial hair

and striae, diminution of the headaches, and increase in general strength. The glucose tolerance is normal (Fig. 17), and all the metabolic studies have returned to the normal range including a twenty-four hour 17-ketosteroid excretion of 9.8 mg. Menstrual periods have returned and have been regular at three week intervals. The patient's hypertension slowly but gradually improved somewhat. It is of interest that it has been possible to reproduce the values of the pre-irradiation metabolic studies by the repeated administration of adrenocorticotrophic hormone for forty-eight hours; that is, a very

In the first approach the prolonged administration of testosterone and its derivatives in an attempt to counterbalance the excessive excretion of corticoids and to re-establish positive nitrogen balance, while the most promising approach, has not proved too successful in the hands of Albright², and others.^{25,70}

In the second approach the stakes are higher and the results a little more encouraging. The administration of estrogens^{25,52,56} represents an attempt at the medical "baso-

TABLE I
SUMMARY OF CHEMICAL CHANGES IN CASE VII AFTER ROENTGEN TREATMENT
(Average values)
4,500 r to pituitary January 12 to 28, 1948

Adm.	Date	Blood Pressure Av. mm. Hg.	Weight	Fasting Blood Sugar mg. per 100 cc.	Eosinophils per cu. mm. (normal 100-250)	Uric Acid } Creatinine } Ratio (normal 0.52 ± 0.05)	Leukocyte Count	Poly-morpho-nuclears	Lympho-cytes	Hemat-ocrit	CO ₂ mm/l	Serum Chloride mEq/l	17-Ketosteroids mg. in 24 hr.	11-Oxy-steroids mg. in 24 hr.
1st	1/1	220/130	67.4	202	4	1.10	16,200	80%	15%	47%	29.9	94	23	0.65
After roentgen treatment	1/29	194/112	64.2	105	6	0.83	11,450	—	—	47%	28.7	94	10	—
2nd 7 wk.	3/2 3/7	160/110	69.2 (57.4)	96	47	0.63	10,250	74%	24%	45%	—	—	7	—
3rd 13 wk.	4/12 4/17	174/106	68	100	48	0.56	11,750	73%	24%	46%	28	106	—	—
4th 18 wk. after roentgen treatment	5/24 5/27	168/80	71.2	97	61	0.50	10,800	72%	25%	41%	25	101	6.5	0.14
5th 36 wk.	9/20 9/29	190/110 130/100	68 66.6	70	86 114	0.50	8,600	65%	29 %	44%	24.3	106	9.8	—

low eosinophil and lymphocyte count, high uric acid/creatinine ratio and markedly increased 17-ketosteroid excretion up to levels of 53 mg. in twenty-four hours (see Table I).

THERAPY IN CUSHING'S DISEASE

On the basis of the present day concept of the pathological physiology of Cushing's syndrome two general approaches to therapy readily suggest themselves: (1) the use of measures to counteract those metabolic effects of the pituitary-adrenal cortical axis which lead to pathological changes, and (2) the direct attack on the excessive secretory activity of either the pituitary basophilic cells, the adrenal cortical cells, or both. At present there is no one adequate or satisfactory therapy for Cushing's disease.

philectomy" in that it is felt that these hormones might suppress the activity of the basophils. Effects are not satisfactory although a few good results have been reported, usually only of a temporary nature. Testosterone might also have a somewhat suppressive action on the basophils and because of its dual action it would appear the agent of choice in what is, by and large, a disappointing therapeutic approach.

In cases which do not show demonstrable tumors of the adrenals, a few good (but sometimes temporary) results have been reported following the irradiation of the pituitary area or of the adrenal regions. Even in the presence of adrenal tumors one might expect a certain amount of improvement by decreasing pituitary stimulation, but the activity of these tumors is often

independent of any tropic hormones, as any malignant growth would be by definition. The surgical removal of adrenal tumors causing the adrenogenital syndrome has shown good results in many cases, especially in the series at the Mayo Clinic.⁶⁸ Partial removal of the adrenals in cases of hyperplasia and Cushing's syndrome, often as a two stage procedure, is fraught with great dangers and is only rarely successful. Adrenal insufficiency often supervenes, especially since a normal adrenal, if present, will show marked involution if the other adrenal is hyperplastic.⁶⁹ Such surgical procedures will depend on the availability of adequate adrenal cortical replacement therapy after the operation. Great advances have been made^{5,64} and in years to come these procedures might lend themselves to more general use. Meanwhile the therapy of Cushing's syndrome is still an unsatisfactory one. The majority of the patients die of the disease in a few years, and others, after considerable improvement, have relapses. In assaying results of treatment, the tendency of benign endocrine tumors toward spontaneous remissions must always be kept in mind. Cushing's original case, Minnie G. (Case 7, reference 15), was followed from 1910 for many years with minor variations in her condition, and was still alive March 10, 1941.

As soon as the diagnosis of Cushing's syndrome is made or suspected, all reasonable means of proving or excluding an adrenal tumor should be employed, even to bilateral exploration of the adrenal areas, if there is evidence enough to justify it.

The therapeutic attempts in Cushing's disease so far have been irradiation of the pituitary region, irradiation of the adrenal areas, partial adrenalectomy, administration of estrogens or androgens, either singly or together, and occasionally direct surgical attack on the pituitary gland, which is justified in the rare patient in whom roentgenograms show an enlarged sella turcica. Various diets, with and without insulin, such as low sodium—high potassium,²⁶ low calorie diet,²⁵ changes in protein, fat and carbohydrate⁴² have also been

tried. Thyroid and insulin in varying amounts have also been used, but chiefly to treat symptoms of the disease rather than the disease itself. (The diabetes at times is insulin resistant.) Thyroid has not been used in large doses to see if it has any effect on breaking up the abnormal endocrine cycle.

Reports of good results have followed the use of each method but many of the clinical improvements have been only temporary, with a recurrence of symptoms and death as the usual sequel. All methods of therapy fail in the majority of cases, and the disease ends fatally.

It is impossible to sum up the end results in all of the cases reported, except the fatal cases. Many are just case reports over a short period of observation, and temporary improvement is not an adequate reason for recommending any form of therapy. A period of at least five years should be allowed to elapse before evaluating the results as in any disease of prolonged or serious nature.

At the present time, more patients have been benefited, and more prolonged remissions have been obtained, from roentgen irradiation of the pituitary region than from any other method. These good results, however, have been secured in only a small minority of the total number of patients, and the great majority have resisted all forms of therapy. Most of the patients have received roentgen treatments to the pituitary region, many in conjunction with, or before or after other forms of therapy, making it very difficult, if not impossible, to allocate the credit for any benefit which ensues. Complete and lasting remissions are rare indeed, but those obtained by or following roentgen irradiation of the pituitary region seem to outnumber those obtained by any other method. A survey of the available literature reveals that roentgen treatments were given a trial in 42 of the cases reported. Definite improvement followed irradiation rather promptly in 16 patients, or 38 per cent. Seven of these, or 17 per cent, have been prolonged and continued remissions, or, as

Albright so aptly puts it, "have ceased having the signs and symptoms of Cushing's disease."

Finally, in evaluating these and all other results, the peculiar tendency of this disease to cyclic variations and spontaneous remissions^{3,63} (as in other endocrine disorders) must always be kept in mind. More patients have had roentgen therapy than any other form of treatment, so that spon-

of the method as one died a few weeks after treatment, before time enough had elapsed to determine the result, and the other one received only a single series of treatments, with a relatively small dose. Case I, who was markedly improved after roentgen treatment, relapsed and died four years later. Cases II, V and VII have ceased having signs or symptoms of the disease, Case II for sixteen years, Case V for seven

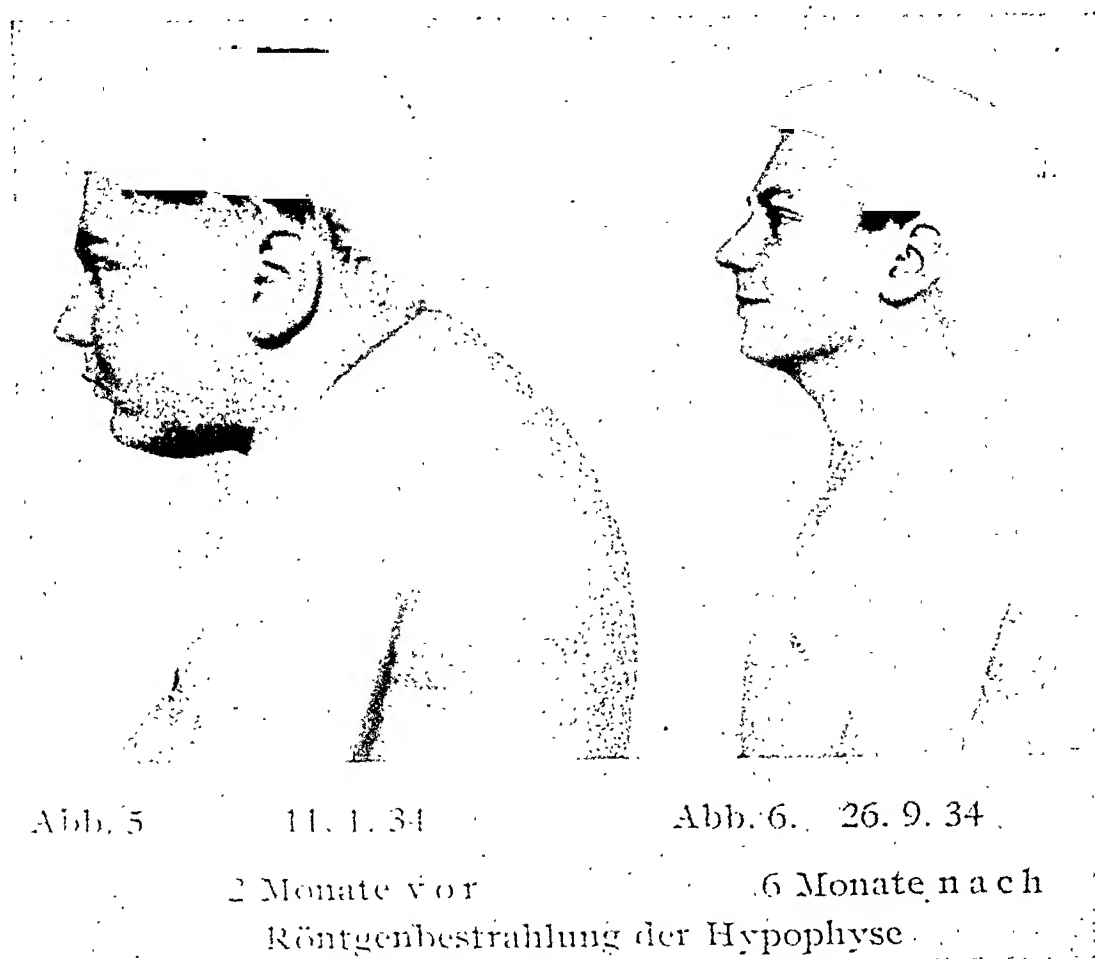


FIG. 18. Jamin's case, two months before and six months after roentgen therapy to the pituitary region.

taneous remissions, if occurring regularly or in any appreciable percentage, would occur in a higher percentage *coincident* with irradiation of the pituitary body. Even so, it seems rather striking and unusual that of our 6 cases of Cushing's disease,* 4 have had marked improvement following irradiation of the pituitary region. The other 2 cannot be counted as failures

* Case IV, adrenogenital syndrome due to adrenal tumor, is not considered as a case of Cushing's disease.

years. The exact dose of roentgen radiation which should be given, the quality and the timing are uncertain. Some of the patients reported in the literature have received much more total dosage than our patients, without permanent benefit. Many patients received doses similar to those we gave, also either without effect or with only temporary benefit, and one patient at least, possibly more, received a much smaller dose with a prolonged remission, which

TABLE II

BASOPHILISM—CASES IN THE LITERATURE WITH IRRADIATION TO THE PITUITARY GLAND

42 cases reported had roentgen therapy to pituitary region

Age range—at onset of symptoms—8–41 yr., average 23.2 yr.

at death—11–45 yr., average 30.2 yr.

Duration of nonfatal cases when reported: range 1–15 yr., average 4.9 yr.

Sex distribution: 29 females, 12 males.

Clinical features:

Typical appearance	42/42*
Amenorrhea—impotence	38/42
Osteoporosis	34/42
Abnormal sugar metabolism	33/42
Hypertension	40/41
R.B.C. over 6 million	5/28
R.B.C. range 4.3–6.3 million, average 5.2 million	

Pathological findings:

Autopsies	19/42
Basophil adenoma	11/20 (one "negative" biopsy)
Crooke's changes	15/15
Adrenal hyperplasia	14/17

Roentgen therapy:

Dose stated	16/42
Two portals	9/13
Three portals	4/13
200–210 kv.	9/14
180–185 kv.	4/14
160 kv.	1/14

Course minimum dose: 380 r × 2 (our Case I)

Course maximum dose: 3800 r via 3 unequal portals (Lawrence)⁴³

?6000 r—uncertain if in one course (Cervino)⁹

Doses in the 9 almost cured:

Jamin ³⁸	450 r × 3
Gaertner ²³	500 r × 3
Cervino ⁹	6000 r total
Our Case II	700 r × 2, repeated once; 750 r × 2 repeated 6 times
Our Case V	1200 r × 2; 1000 r × 2; 1040 r × 2
Our Case VII	1500 r × 3
Luft ⁴⁶	3 cases—dose not stated

Results

Total improved	16/42
Improved but relapsed	3/16
(Our Case I, Paschke, ⁵² Albright ¹ Case 1)	
Improvement slight or moderate	4/16
(Lawrence, ⁴³ Wohl, ⁷¹ Whitehead, ⁶⁹ Wright, ⁷² Case 2)	
Almost completely cured	9/16
(Our Cases II, V, VII, Jamin, ³⁸ Gaertner, ²³ Cervino, ⁹ Luft, ⁴⁶ Ne, ¹⁵ 18, 23)	

might be called a cure, as he died in the German army and autopsy showed no tumor or abnormality of any of the endocrine glands. (The only justification for speaking of a "cure" in this disease is when the patient dies of something else while entirely free of symptoms of Cushing's disease as in Jamin's case³⁸ (Fig. 18).)

The explanation of the good results of various forms and types of therapy will be difficult if not impossible until the etiology of the disease is determined. The symptoms and signs of the syndrome are those of hyperadrenocorticism, but if the disease began in and was limited to abnormal function of the adrenal glands, there should be no effect from therapy directed to the pituitary gland. The latter has many and diverse functions, with evidence of at least twelve different tropic hormones originating in it, six having been isolated and identified.²³ The adrenotropic hormone could be in excess, stimulating the adrenals, or abnormal in type. Any injury to the pituitary gland could suppress the disordered pituitary function and permit the adrenal functions to return to normal with consequent improvement provided no permanent changes in adrenal structure or function have taken place. Thus Naffziger's patient, reported by Lissner,⁴⁵ showed marked improvement for twelve months after removal of portions of the pituitary gland which histopathologically did not show either a basophil adenoma or Crooke's changes. Irradiation to the pituitary gland is another form of damage, sometimes followed by improvement. The action of testosterone or stilbestrol could be explained by suppression of the pituitary gland secretions, as considerable evidence has been built up to show that excessive administration of one hormone reacts on the other endocrine glands. Furthermore, continued thyroid or testosterone injections have been

* The numerator in these stated fractions indicates the number of patients who had the particular symptom or sign, while the denominator indicates the total number in whom the particular information was available. For example, the red blood cell count was given in only 28 cases, and was over 6,000,000 in only 5, hence 5/28.

shown to depress pituitary function with a decrease or disappearance of the basophil cells. The common denominator, or the culprit, in the cases of Cushing's disease could therefore still be the pituitary gland, called the Master Gland of the endocrine series by Cushing, and the balance between the various glands can be either upset at any link in the chain, or attacked at any ring between the links. Thus one can explain the spontaneous remissions, as well as the occasional bizarre result such as the patient reported by Anderson and Haymaker,³ in whom marked improvement followed simple exploration of the adrenal areas, no tumor being found, and no resection of adrenal tissue being done. The local injury presumably disturbed or upset the abnormal balance between adrenal and pituitary glands. This balance, as Aub⁵ states, is not a static or permanent affair, but is constantly changing, and in fact requires changing to meet the demands of changes in environment or other bodily demands. Most of the difficulties in the exact diagnosis of Cushing's disease have now been overcome by the use of (a) the accurate measurements of the urinary end products of adrenal excretion, (b) the total circulating eosinophil count and the uric acid-creatinine ratio in the urine, and (c) the adrenocorticotrophic hormone test and the adrenalin test, as reported by Thorn^{64,65} and his collaborators. The use and interpretation of these tests are detailed in Case VII, and were also employed in Cases VIII and IX, to be reported later.

"SUSPECT" GROUP

One of the major difficulties in assaying the results of treatment in this syndrome is the proof or certification that the patient really suffers from this condition. There are many patients presenting themselves with one or more classical features of the disease yet who do not have enough of the signs or symptoms to be really included in the group. There is no one feature of the many which characterize Cushing's syndrome which is essential, as we have said

before, and there is no one criterion or test which is pathognomonic, unless it is the difficult and complicated assays of the adrenal hormones excreted in the urine.

Three types of patients who are often suspected of having Cushing's syndrome are commonly seen in the larger clinics. They are often assumed to be victims of the syndrome and treated as such. These types, as I have seen them are: (a) the dark-skinned, obese, slightly hairy young female, usually resulting from racial or hereditary stock of the same type, and with none of the clinical, roentgenographic or laboratory findings to confirm the tentative diagnosis; (b) the red-faced, obese, hypertensive patient, who, if she has amenorrhea or glycosuria or more than her share of down on her face, is often assumed to have Cushing's syndrome without further proof; (c) the patient with hypothalamic obesity, often with polyphagia, amenorrhea, abdominal striae and hyperostosis frontalis, even sometimes with glycosuria and hypertension—the most difficult of the three to differentiate from true Cushing's syndrome. The absolute level of circulating eosinophils has proved an excellent diagnostic help, in that patients with active Cushing's disease invariably show a level below 50 eosinophils per cu. mm. (normal 100 to 250), whereas in simple obesity the patient tends to show a normal level.

In addition to the 6 indubitable cases reported above, we have treated 15 others in these "suspect" groups, 7 of them rather closely resembling Cushing's syndrome and the other 8 only remotely akin. It is interesting to note that several of these "basophilism suspects" (as they were classified when the Brigham was a stronghold of the Pituitary Army) have been subjectively improved after roentgen irradiation of the pituitary area. We also treated in 1930-1932 a small series of young patients with essential hypertension by irradiating the pituitary region, using doses similar to those in Cases I and III. No definite or lasting improvement in the hypertension

could be demonstrated, but there were transitory and irregular decreases in the blood pressure, such as may be secured when any form of therapy is first tried.

Those patients were treated by request of Dr. Cushing, who was intrigued by the possibility that eclampsia and essential hypertension might be expressions of basophilism.

DETAILS OF ROENTGEN THERAPY

In Cases I, II, and III roentgen treatments to the pituitary region were given with the following factors:

Voltage 182–185 kv. (peak), mechanical rectifier.

Target-skin distance—40 to 46 cm.

Milliamperes—4 to 6.

Portals—8 cm. circle.

Time—25 to 28 minutes.

Filter—0.5 mm. copper plus 1 mm. aluminum.

Estimated single dose—300 to 350 r.

A "series" of treatments in those early days usually consisted of four daily single treatments, two to each temporal area.

Cases V and VI were irradiated with:

200 kv. (constant potential).

50 cm. distance.

0.5 copper plus 1 mm. aluminum filter.

18 milliamperes.

5 cm. circular portals.

250 to 300 r to 1 portal per day alternating right and left temporal areas. Total dose to each temporal area as indicated, 900 to 1,200 r in 6 to 10 days. All doses measured in air without backscatter. Half-value layer = 0.9 mm. of copper.

Case VII received 1,500 r (measured in air without backscatter) through each of three portals, at the rate of 300 r per day, the other factors being the same as above. Case VIII, now receiving treatment, a young man, aged twenty-nine from the West Roxbury Veterans Administration Hospital, will receive 1,500 r measured in air through each of three portals, which will give an estimated dose in the pituitary gland of 1,700 r. This patient has a classical Cushing's disease by symptoms, signs and

laboratory findings, including marked osteoporosis, but without glycosuria or abnormal glucose tolerance curves.

SUMMARY

Seven cases of Cushing's syndrome are presented in detail, six of them definite pituitary basophilism (Cushing's disease), the other one proved to be one of adrenogenital syndrome due to a malignant adrenal tumor. Roentgen irradiation of the pituitary gland was followed by definite improvement in four of the six patients so treated. Two of the patients have returned to normal and have remained well for sixteen years and six years respectively (Cases II, and V). One patient, after marked improvement, had a relapse and died five years later (Case I). The fourth patient, who has shown marked improvement, is too recent to be evaluated as an end result (Case VII). The eighth and ninth patients are undergoing roentgen therapy at present.

The amount, the quality and the timing of roentgen irradiation to the pituitary gland has been variable within wide limits. A summary of the cases from the literature shows even wider variation. Only one-third of the reported cases have shown improvement following roentgen irradiation to the pituitary gland.

CONCLUSIONS

1. If a patient is suspected of having Cushing's disease, the diagnosis can now be made with a high degree of certainty by (a) urinary hormone assays, (b) the uric acid-creatinine ratio, and (c) the adrenocorticotrophic hormone test and the adrenalin test, in addition to the other clinical and laboratory findings noted above.

2. We believe the syndrome to be a definite clinical entity, but quite variable in individual patients. There is no single feature or combination of features which is essential to diagnosis in all patients.

3. The duration of the disease and its severity are probably important factors in treatment and also prognosis. Initiated primarily by excessive secretion of adreno-

corticotropic hormone by the pituitary gland, the course of the disease can probably be stopped or reversed by prompt roentgen irradiation to the region of the pituitary gland early in the course of the disease. After prolonged stimulation by adrenocorticotrophic hormone the adrenal cortices may become hyperplastic so that their hyperfunction becomes independent of pituitary stimulation. The disease then would have to be attacked at the adrenal level.

4. Our plan of treatment at present (August, 1948) is as follows:

- (a) Establishment of diagnosis.
- (b) Investigation of adrenal areas to rule out adrenal tumor. If this can be done,
- (c) Irradiation of pituitary gland.
- (d) If no improvement in signs, symptoms or laboratory findings in three months,
- (e) Irradiation to or surgical exploration of adrenal glands. If no tumor or marked hyperplasia be found:
- (f) Biopsy of adrenal glands followed by roentgen irradiation to both adrenal glands, following the patient's response closely with the three tests noted above.

5. The signs and symptoms of the disease should be ameliorated in at least half of the patients by this program, and prolonged, possibly permanent remissions should be achieved in at least a third of the cases. Permanent or irreversible changes may have taken place in the other patients before therapy is instituted.

Peter Bent Brigham Hospital
Boston 15, Massachusetts

REFERENCES

1. ALBRIGHT, F. Cushing's Syndrome. Harvey Lecture Series. 1942-1943, 38, 123-186.
2. ALBRIGHT, F., PARSON, W., and BLOOMBERG, E. Cushing's syndrome interpreted as hyperadrenocorticism leading to hyperglucocortecogenesis; results of treatment with testosterone propionate. *J. Clin. Endocrinol.*, 1941, 1, 375-384.
3. ANDERSON, E., and HAYMAKER, W. Cushing's syndrome. *J. Nerv. & Ment. Dis.*, 1944, 99, 511-520.
4. ANDERSON, N. L. Laurence-Moon-Biedl syndrome; case report with complete autopsy. *J. Clin. Endocrinol.*, 1941, 1, 905-911.
5. AUB, J. C., and KARNOFSKY, D. Medical progress; endocrinology treatment of abnormalities of the anterior pituitary gland. *New England J. Med.*, 1942, 226, 759-768.
6. BABINSKI, J. Tumeur du corps pituitaire sans acromégalie et avec arrêt de développement des organes genitaux. *Rev. neurol.*, 1900, 8, 531-533.
7. BLAND, P. B., and GOLDSTEIN, L. Pituitary basophilism. *Surg., Gynec. & Obst.*, 1937, 65, 644-656.
8. BRAUER, E. W. Zur Kenntnis des Morbus Cushing. *Endokrinologie*, 1937, 19, 10-19.
9. CERVINO, J. V., MORATO MANARO, J., and BAZZANO, H. Tratamiento del síndrome de Cushing. *Arch. urug. de med., cir. y especialid.*, 1945, 27, 247-265.
10. CLUXTON, H. E., JR., BENNETT, W. A., POWER, M. H., and KEPLER, E. J. Cushing's syndrome without adenomatous or hyperplastic changes in the pituitary body or adrenal cortices and complicated by alkalosis. *J. Clin. Endocrinol.*, 1945, 5, 61-69.
11. CRAIG, J., and CRAN, B. S. Basophil adenoma of the pituitary gland. *Quart. J. Med.*, 1934, 3, 57-62.
12. CROOKE, A. C. Change in the basophil cells of the pituitary gland common to conditions which exhibit the syndrome attributed to basophil adenoma. *J. Path. & Bact.*, 1935, 41, 339-349.
13. CROOKE, A. C., and CALLOW, R. K. The differential diagnosis of forms of basophilism (Cushing's syndrome), particularly by the estimation of urinary androgens. *Quart. J. Med.*, 1939, 8, 233-249.
14. CUSHING, H. The Pituitary Body and Its Disorders. J. B. Lippincott Co., Philadelphia, 1912.
15. CUSHING, H. The basophil adenomas of the pituitary body and their clinical manifestations (pituitary basophilism). *Bull. Johns Hopkins Hosp.*, 1932, 50, 137-195.
16. CUSHING, H. Further notes on pituitary basophilism. *J.A.M.A.*, 1932, 99, 281-284.
17. CUSHING, H. "Dyspituitarism"; twenty years later. *Arch. Int. Med.*, 1933, 51, 487-557.
18. DAVIDOFF, L. M. Studies in acromegaly. II. Historical note. *Endocrinology*, 1926, 10, 453-460.
19. DEAKINS, M. L., FRIEDGOOD, H. B., and FERREBEE, J. W. Some effects of testosterone, testosterone propionate, methyl testosterone, stilbestrol, and x-ray therapy in a patient with Cushing's syndrome. *J. Clin. Endocrinol.*, 1944, 4, 376-384.
20. DE LA BALZE, F. A., REIFENSTEIN, E. C., JR., and ALBRIGHT, F. Differential blood counts in

- certain adrenal cortical disorders (Cushing's syndrome, Addison's disease and panhypopituitarism). *J. Clin. Endocrinol.*, 1946, 6, 312-319.
21. DOUGHERTY, T. F., and WHITE, A. Evaluation of alterations produced in lymphoid tissue by pituitary-adrenal cortical secretion. *J. Lab. & Clin. Med.*, 1947, 32, 584-605.
 22. ERDHEIM, J. Zur normalen und pathologischen Histologie der Glandula thyreoidea, parathyreoidea und Hypophysis. *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, 33, 158-236.
 23. EVANS, H. M. Recent advances in our knowledge of the anterior pituitary hormones. *Am. Scientist*, 1947, 35, 465-484.
 24. FORSHAM, P. H., THORN, G. W., PRUNTY, F. T. G., and HILLS, A. G. Clinical studies with pituitary adrenocorticotropin. *J. Clin. Endocrinol.*, 1948, 8, 15-65.
 25. FREYBERG, R. H., BARKER, P. S., NEWBURGH, L. H., and COLLIER, F. A. Pituitary basophilism (Cushing's syndrome). *Arch. Int. Med.*, 1936, 58, 187-212.
 26. FREYBERG, R. H., and GRANT, R. L. Calcium and phosphorus metabolism in a verified case of pituitary basophilism. *Arch. Int. Med.*, 1936, 58, 213-228.
 27. FREYBERG, R. H., and NEWBURGH, L. H. Obesity and energy exchange in a verified case of pituitary basophilism. *Arch. Int. Med.*, 1936, 58, 229-234.
 28. FRITSCHKE and KLEBS, E. Ein Beitrag zur Pathologie des Riesenwuchses. Klinische und pathologisch-anatomischen Untersuchungen. Leipzig, 1884.
 29. FRÖHLICH, A. Ein Fall von Tumor der Hypophysis cerebri ohne Akromegalie. *Wien. klin. Rundschau*, 1901, 15, 883-886; 906-908.
 30. FULLER, C. J., and RUSSELL, D. S. Chromophobe adenoma of the pituitary associated with Cushing's syndrome. *Lancet*, 1936, 2, 181-183.
 31. FULTON, JOHN F. Harvey Cushing: A biography. Charles C Thomas, Springfield, Illinois, 1946, p. 616.
 32. *Ibid.* Fröhlich leaving Vienna. Pp. 271-272.
 33. GAERTNER, K. Pathologisch-anatomische Untersuchung eines nach Röntgenbestrahlung geheilten Falles von Morbus Cushing. *Virchows Arch. f. Path. Anat.*, 1943, 310, 388.
 34. GRATTON, A. Maladie de Cushing. *Union méd. du Canada*, 1937, 66, 1014-1025.
 35. HEINBECKER, P. Pathogenesis of Cushing's syndrome. *Medicine*, 1944, 23, 225-247.
 36. HENDERSON, W. R. The pituitary adenomata; follow up study of the surgical results in 338 cases (Dr. Harvey Cushing's series). *Brit. J. Surg.*, 1939, 26, 811-921.
 37. HILLS, A. G., FORSHAM, P. H., and FINCH, C. A. Changes in circulating leukocytes induced by the administration of pituitary adrenocorticotrophic hormone (ACTH) in man. *Blood*, 1948, 3, 455-468.
 38. JAMIN, F. Die hypophysäre Plethora (Cushing'sche Krankheit: pituitary basophilism). *München. med. Wchschr.*, 1934, 81, 1045-1048; 1085-1088.
 39. KEPLER, E. J. Relationship of "Crooke's changes" in the basophilic cells of the anterior pituitary body to Cushing's syndrome (pituitary basophilism). *J. Clin. Endocrinol.*, 1945, 5, 70-75.
 40. KESSEL, F. K. Morbus Cushing: Ein Überblick über Klinik und Kasuistik des basophilen Hypophysenadenoms. *Ergebn. d. inn. Med. u. Kinderh.*, 1936, 50, 620-678 (see p. 637).
 41. KRAUS, E. J. Adiposogenital dystrophy (Case 3). *Med. Klin.*, 1924, 20, 1290-1292; 1328-1330.
 42. KRAUS, E. J. Über Beziehungen der chromophilen Zellen der Hypophyse zum Kohlehydrat-, Fett- und Cholesterinstoffwechsel. *Med. Klin.*, 1933, 29, 449-451.
 43. LAWRENCE, R. D. Case report in discussion on suprarenal and pituitary tumours. *Proc. Roy. Soc. Med.*, 1933-1934, 27, 275-277.
 44. LAYANI, F., GOUTNER, and GASCON. Maladie de Cushing juvénile; effets très heureux de la radiothérapie hypophysaire. *Ann. d'endocrinol.*, 1939, 1, 197-207.
 45. LISSER, H. Hypophysectomy in Cushing's disease. *J. Nerv. & Ment. Dis.*, 1944, 99, 727-733.
 46. LUFT, R. A study on hirsutism; Cushing's syndrome and precocious puberty. *Acta med. Scandinav.*, supp. 149, 1944, pp. 1-119.
 47. MARIE, P. (1) Sur deux cas d'acromegalie; hypertrophie singulière, non congenitale, des extrémités supérieures, inférieures, et céphalique. *Rev. de méd.*, 1886, 6, 297-333.
 48. MCKENZIE, K. G., and SOSMAN, M. C. Roentgenological diagnosis of craniopharyngeal pouch tumors. *Am. J. Roentgenol. & Rad. Therapy*, 1924, 11, 171-176.
 49. MINKOWSKI, O. Ueber einen Fall von Akromegalie. *Berl. klin. Wchschr.*, 1887, 24, 371-374.
 50. MENZEL, W. Zur Pathogenese der Cushing'schen Krankheit. *Ztschr. f. klin. Med.*, 1937, 131, 565-582.
 51. PARDEE, I. H. Basophilic syndrome of the pituitary; pituitary basophilism (Cushing). *Arch. Neurol. & Psychiat.*, 1934, 31, 1007-1025.
 52. PASCHKIS, K. E., HERBUT, P. A., RAKOFF, A. E., and CANTAROW, A. A case of Cushing's syndrome with adrenal cortical hyperplasia, without pituitary basophilic adenoma or hyperplasia. *J. Clin. Endocrinol.*, 1943, 3, 212-217.
 53. PERLOFF, W. H., ROSE, E., and SUNDERMAN, F. W. Therapeutic observations in Cushing's syndrome. *Arch. Int. Med.*, 1943, 72, 494-505.
 54. PRITCHARD, E. A. B. Pituitary basophilism. *Proc. Roy. Soc. Med.*, 1934, 27, 673-675.
 55. RAAB, W. Cerebral obesity and genital atrophy

- (Case 2). *Wien. Arch. f. inn. Med.*, 1924, 7, 443-530.
56. RAKOFF, A. E., CANTAROW, A., and PASCHKIS, K. E. Cushing's syndrome; two cases treated with stilbestrol. *J. Clin. Endocrinol.*, 1941, 1, 912-915.
 57. SELYE, H. The general adaptation syndrome and the diseases of adaptation. *J. Clin. Endocrinol.*, 1946, 6, 117-230.
 58. SEVERINGHAUS, A. E. The cytology of the pituitary gland. *A. Research Nerv. & Ment. Dis., Proc.* (1936), 1938, 17, 69-117.
 59. SPENCE, H. M., and THOMPSON, F. G., JR. Hormone-producing tumor of adrenal cortex, with congenital absence of contralateral adrenal gland; report of a case. *New England J. Med.*, 1947, 236, 13-20.
 60. SUSSMAN, M. L., and COPLEMAN, B. Roentgenographic appearance of the bones in Cushing's syndrome. *Radiology*, 1942, 39, 288-292.
 61. TEEL, H. M. Basophilic adenoma of the hypophysis with associated pluriglandular syndrome. *Arch. Neurol. & Psychiat.*, 1931, 26, 593-599.
 62. TEEL, H. M., and CUSHING, H. Separate growth-promoting and gonad-stimulating hormones of the anterior hypophysis; historical review. *Endokrinologie*, 1930, 6, 401-420.
 63. THOMPSON, K. W., and EISENHARDT, L. Further consideration of the Cushing syndrome. *J. Clin. Endocrinol.*, 1943, 3, 445-452.
 64. THORN, G. W., with the collaboration of FORSHAM, P. H., and EMERSON, K., JR. The Diagnosis and Treatment of Adrenal Insufficiency. Am. Lecture Series. Charles C Thomas, Springfield, Illinois, 1949.
 65. THORN, G. W., DORRANCE, S. S., and DAY, E. Addison's disease; evaluation of synthetic desoxycorticosterone acetate therapy in 158 patients. *Ann. Int. Med.*, 1942, 16, 1053-1096.
 66. ULRICH, H. L. Basophil adenoma of the pituitary gland. *Minnesota Med.*, 1935, 18, 73-77.
 67. WALL, C. Adreno-genital syndrome (Cushing type). *Proc. Roy. Soc. Med.*, 1934, 27, 395-397.
 68. WALTERS, W., WILDER, R. M., and KEPLER, E. J. The suprarenal cortical syndrome with presentation of ten cases. *Ann. Surg.*, 1934, 100, 670-788.
 69. WHITEHEAD, W. K. Cushing's syndrome. *Harper Hosp. Bull.*, 1944, 2, 5-9.
 70. WHITELAW, M. J. A case of Cushing's syndrome treated with testosterone propionate. *J. Clin. Endocrinol.*, 1944, 4, 480-482.
 71. WOHL, M. G., MOORE, J. R., and YOUNG, B. R. Basophilic adenoma (pituitary basophilism). *Radiology*, 1935, 24, 53-57.
 72. WRIGHT, C. A. Pituitary basophilism. *M. Rec.*, 1935, 141, 191-196.



THE DEVELOPMENT OF THE TAUTOGRAPH AND THE ADVANTAGES OF AUTOMATIZATION IN CARDIOVASCULAR ANGIOGRAPHY*

By WENDELL G. SCOTT, M.D., and SHERWOOD MOORE, M.D.

ST. LOUIS, MISSOURI

HERETOFORE, the success of angiography has depended on estimating accurately the time at which the diodrast would reach a particular chamber of the heart or great vessel and making the roentgen-ray exposure at that precise moment. Physiological tests were used to calculate the circulatory time and, while fairly satisfactory, they consumed the operator's time and usually did not give an indication of what type of congenital shunt or shunts might be present in the circulation.

Angiographic procedures have been further handicapped by the lack of automatic roentgenographic equipment that was capable of making a series of six, eight, ten, or twelve exposures at an interval of one second or less and synchronized with a Potter-Bucky grid. Hence, if angiography was to become a successful routine roentgenographic procedure, the above problems had to be overcome. To do this it was necessary to construct equipment that could take a series of six to twelve roentgen films at one second intervals or less and thus obtain a continuous series of films picturing the bolus of diodrast as it circulated through the chambers of the heart and lungs and into the aorta. In this way the chambers of the heart, the positions or transpositions of the great vessels, the congenital shunts, and the abnormal sequences in the time of visualization of the various chambers of the heart could be recorded on a series of films for study without regard to a pre-estimated circulation time or the fear of "missing" the diodrast at the crucial moment.

The "tautograph" (Fig. 1) was designed

to fulfill these purposes and offers the following advances:

1. It produces a sequence of six to ten angiograms at a one second interval to give a continuous picture of the bolus of diodrast as it circulates through the chambers of the heart and lungs and into the aorta.

2. It eliminates "forecasting" the circulation time and guessing the "route" through the heart.

3. It eliminates estimating the exposure time for only one, two or three films which at best do not provide a complete record of the cardiac circulation.

4. It reduces the number of repeated injections of diodrast that was formerly required to obtain angiograms with the diodrast in different cardiac chambers and great vessels. One injection of diodrast is now sufficient for recording the cardiopulmonary circulation.

5. It eliminates "technician crews" that were necessary for the operation of manual angiographic equipment that could make six to ten exposures.

6. It achieves added clarity and contrast in the films by using a self-cocking Potter-Bucky grid.

7. It has simplified the roentgenographic technique by completely automatizing the advance of the unexposed cassettes, the energizing of the Potter-Bucky grid, the initiating and ending of the roentgen-ray exposure, and the retiring of the exposed cassette.

8. It permits the taking of angiograms with the patient in the semi-erect or in the horizontal position. This is an important

* From the Department of Radiology, Washington University School of Medicine, St. Louis, Missouri. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

advantage in the examination of children and infants under anesthesia.

9. It reduces the hazard of excessive roentgen-ray exposure to the patient as roentgenoscopy is not employed.

The "tautograph" was designed by one of us (W.G.S.) and constructed in the shop

exposure. The time interval consumed in the advance of the cassette, in its stoppage, exposure, and retirement is one second or less. The chain conveyor is energized by an electric motor which operates through reduction gears. The roentgen-ray time exposure is initiated by the self-cocking

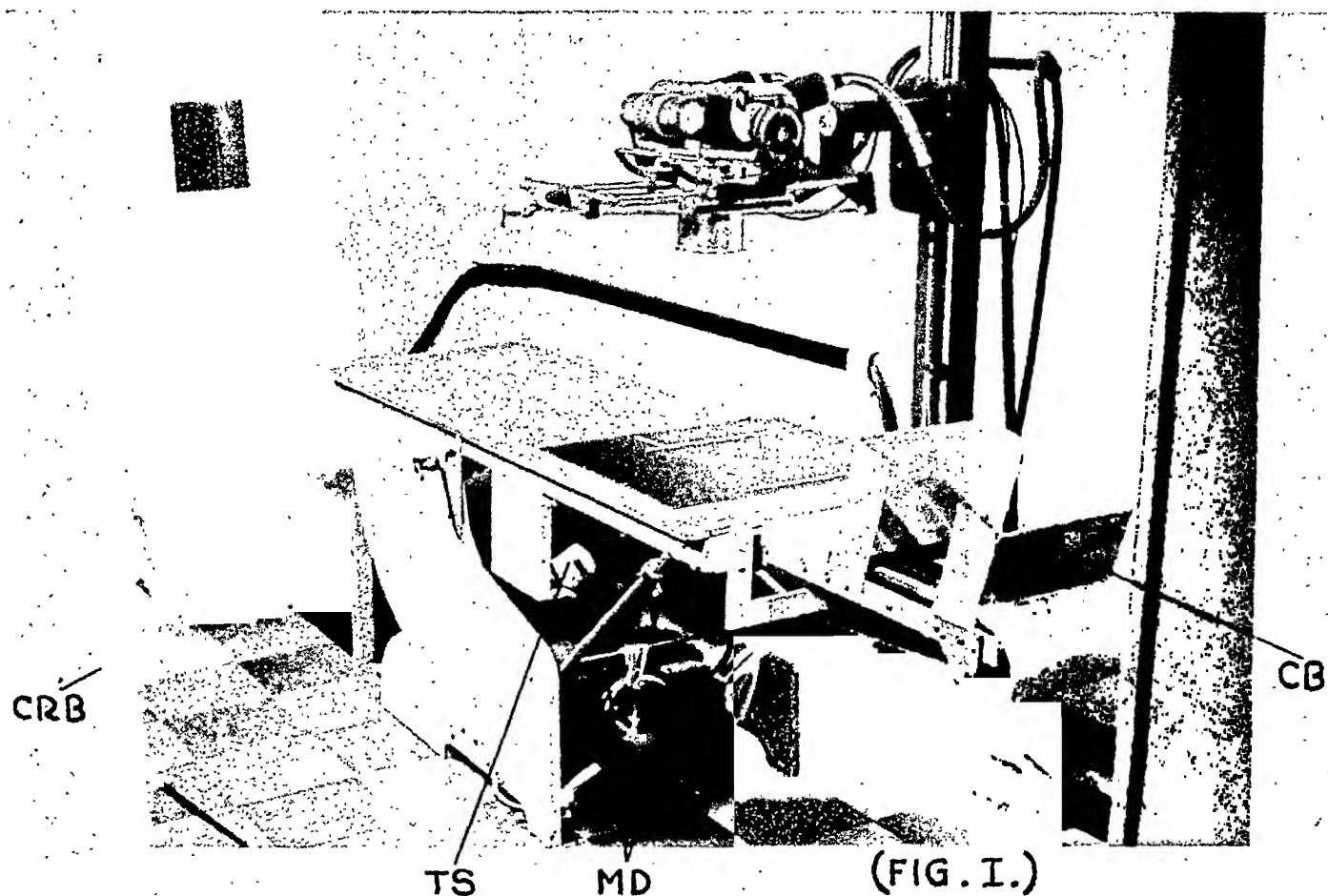


FIG. I. Side view of the tautograph showing the position of the tube stand. *CB*, cassette loading bin; *CRB*, cassette receiving bin; *TS*, switch for tilting table from horizontal to semi-erect position; *MD*, motor drive for tilting mechanism of table.

of Mr. R. H. Tontrup. This equipment consists of a tilting diagnostic roentgenographic table with angle irons fitted under the top to which rollers were fastened for carrying the cassettes. A heavy roller chain with steel lugs spaced at 14 inches carries the cassettes into position and stops the cassette for $\frac{1}{3}$ of a second during which a roentgen-ray exposure of $\frac{1}{15}$ to $\frac{1}{20}$ of a second is made. The cassette is then moved forward and retired into the receiving bin while the next is brought into position for

Potter-Bucky grid, which, in turn, is controlled by a contact switch on the power sprocket connected to the reduction unit.

With the development of cardiac surgery and the greater necessity for the accurate diagnosis of congenital heart disease an increased need developed for angiocardiology. To meet this demand we realized that special equipment would be necessary to make angiography a practical and successful routine procedure.

Late in 1945 one of us (W.G.S.) had

made preliminary sketches of the tautograph. In July, 1946, we asked Mr. R. H. Tontrup, who had assisted us in the development of the Kieffer-Moore laminagraph, to undertake construction of this equipment. Funds were limited and it was necessary to develop the machine with as little expense as possible. To this end we found a used Kelley-Koett Model "S" tilting diagnostic roentgenographic table and began altering it for our purpose by fitting it with $1\frac{1}{2}$ inch steel angle irons (Fig. 3, 4, 5) running parallel to the sides of the table

given to devising a special light-weight cassette, but this would have involved additional expense, prolonged the time and



FIG. 2. Side view of tautograph tilted in the semi-erect position at 45° . The table top and the Potter-Bucky grid have been removed.

and spaced the exact width of a Kelley-Koett 11 by 14 inch cassette.

The 11 by 14 inch cassette was selected as the most desirable size since it was sufficiently large to cover the heart and great vessels on an adult as well as on a child and weighed much less than the large 14 by 17 inch cassette. The weight factor was important, for even the 11 by 14 inch cassette weighed $6\frac{1}{2}$ pounds and with ten of them stacked together added a total of 65 pounds to the weight of the table. Furthermore, in our system at least four cassettes would be on the conveyor system at any one moment. One can readily appreciate that considerable force is necessary to move them quickly in rapid succession. Thought was

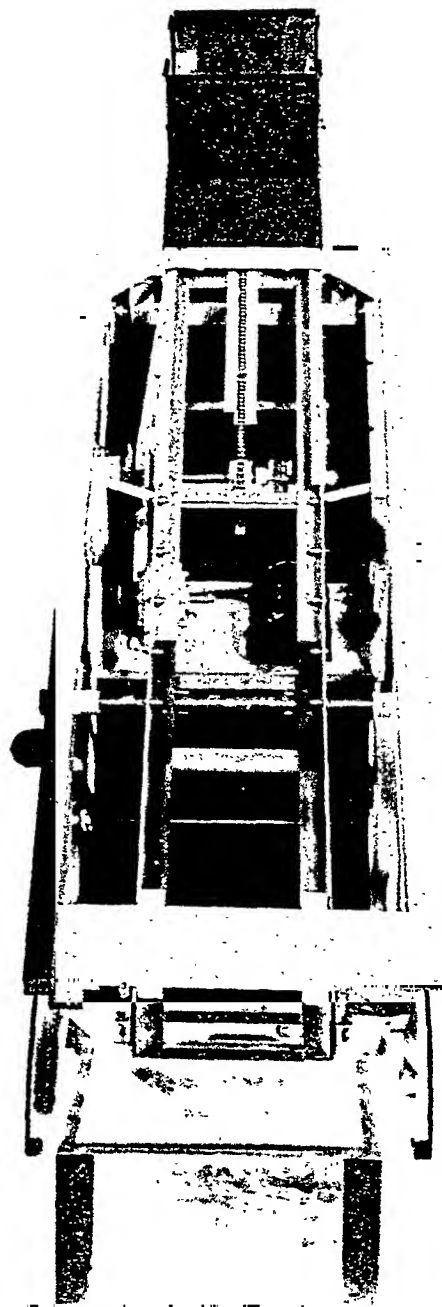


FIG. 3. End view of the tautograph as it is tilted in the 45° position with the table top and the Potter-Bucky grid removed to illustrate the angle irons and brass rollers on which the cassettes are carried and the chain conveyor for moving the cassettes into position.

would have been non-standard items.

To expedite the moving of the cassettes along the channel irons, $\frac{5}{8}$ inch brass rollers (BR) (Fig. 4 and 5) were spaced every 5

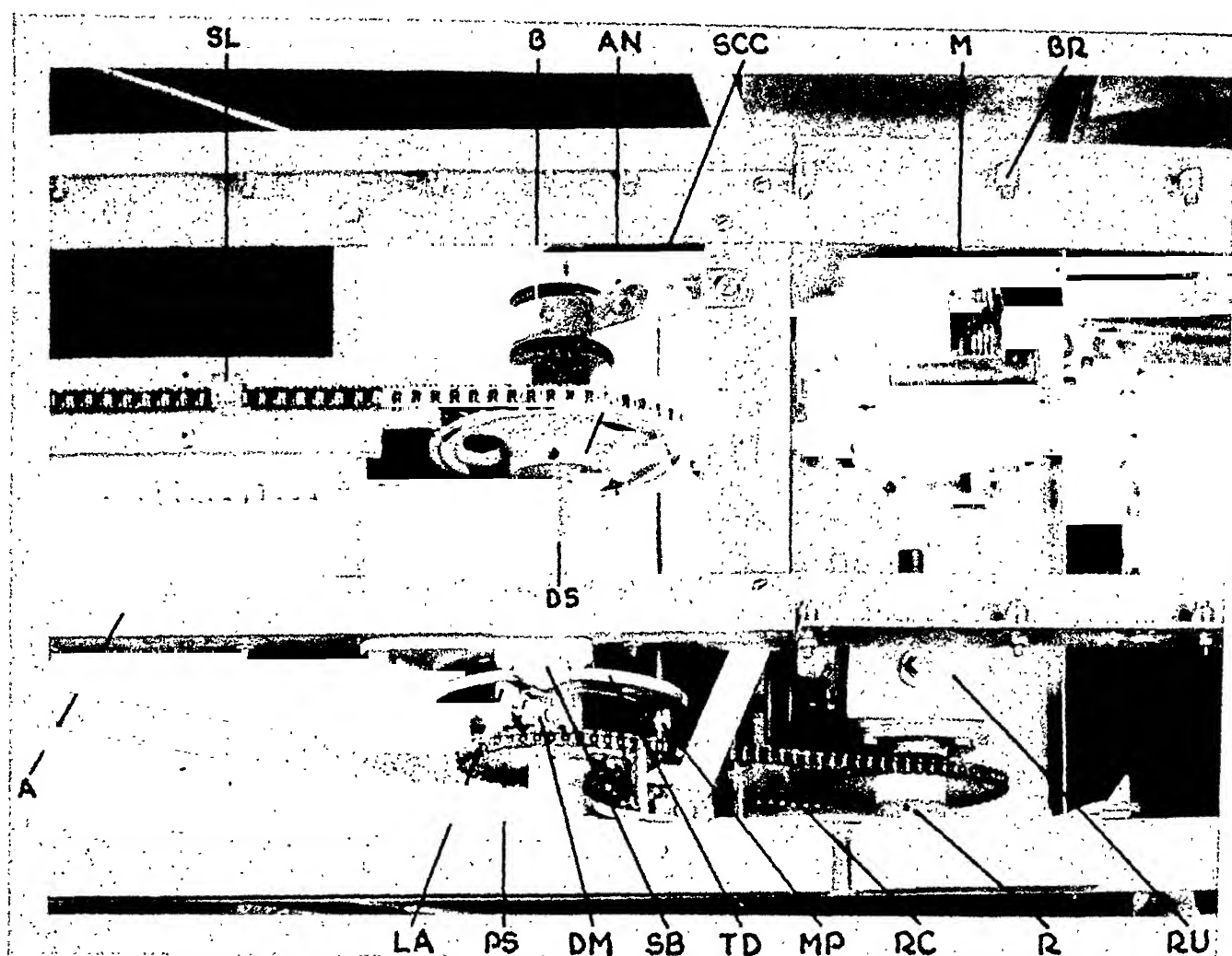


FIG. 4. Detailed vertical view of the conveying mechanism of the tautograph with the table top removed.

- SL* Steel lug. A cassette is placed between two such steel lugs.
- B* Brake on drive shaft to provide instant stoppage and elimination of back lash.
- AN* Adjustable screw for tightening or loosening the brake band.
- SCC* Steel sprocket which powers the roller chain for conveying the cassettes.
- M* $\frac{1}{4}$ h.p. single phase Emerson electric motor.
- BR* $\frac{5}{8}$ inch brass roller.
- DS* Drive shaft.
- A* $1\frac{1}{2}$ inch steel angle iron on which brass rollers are secured for carrying the cassettes.
- LA* Long arm of right angle bar of dog mechanism.
- PS* Power sprocket.
- DM* Dog mechanism on power sprocket.
- SB* Steel block or cam for interrupting transmission of power to the drive shaft.
- TD* Timing disc.
- MP* Metal pin in timing disc against which *LA* strikes to revolve the drive shaft.
- RC* $\frac{3}{8}$ inch pitch roller chain extending between reduction unit and power sprocket.
- R* Ratchet to permit adjustment of cassette conveyor system without turning the reduction unit and motor.
- RU* Winfield H. Smith speed-reducing unit No. $3\frac{1}{2}$ B.

inches along the sides of the channel irons to permit the cassettes to roll along easily.

Knowing the weight and the number of cassettes to be moved and establishing the rate of exposure as one per second, the next problem was to calculate the size of the electric motor that was necessary and to

devise some means of slowing down the motor speed for the drive shaft (*DS*) (Fig. 4 and 6) of our conveyor system. After several trials a single phase, $\frac{1}{4}$ horse power, 60 cycle, 1,725 r.p.m. motor was mounted on a steel cross plate beneath the table and connected by a rubber "V" belt to a

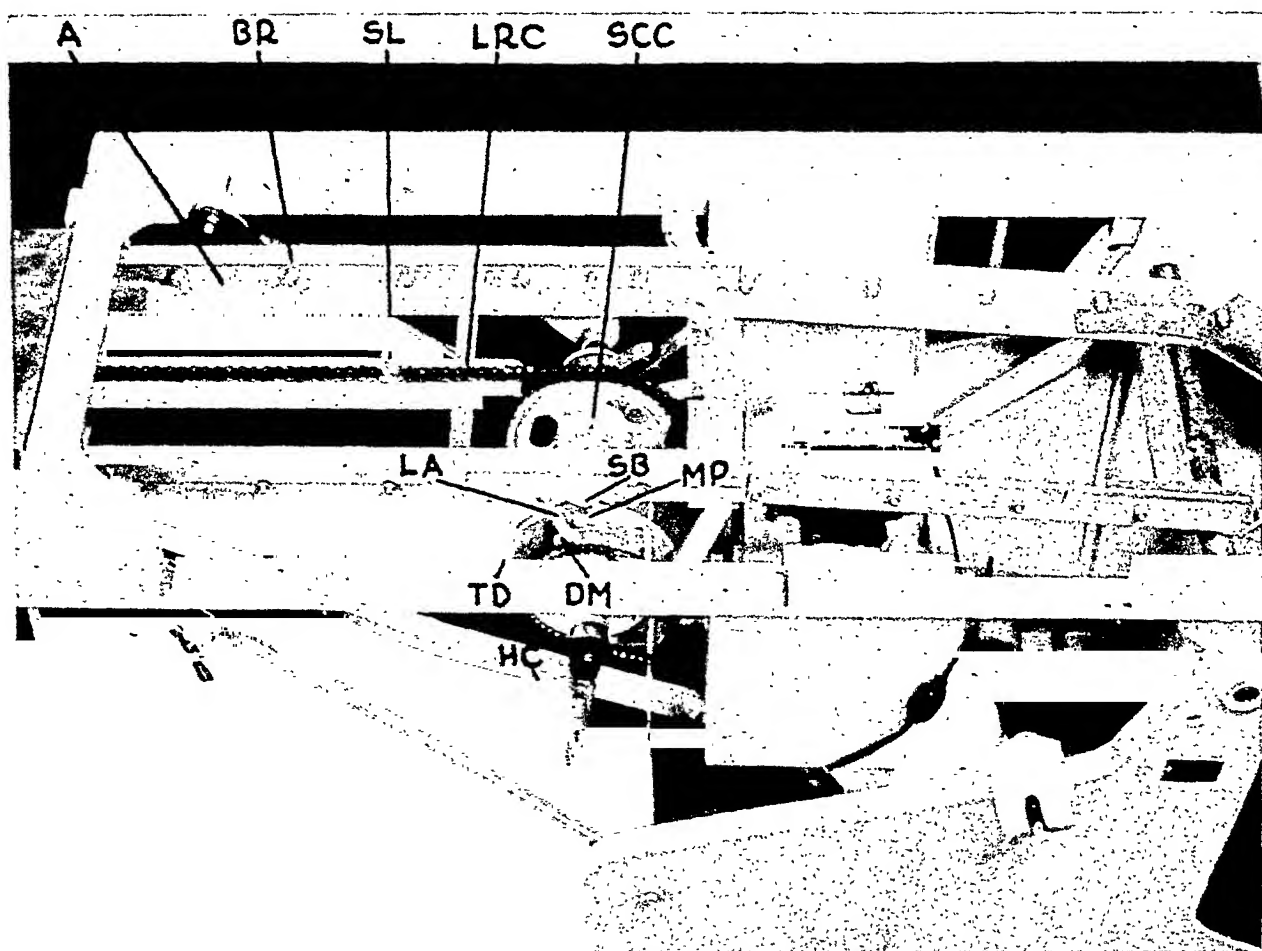


FIG. 5. Detailed side view from above with the table top and bucky removed to illustrate the power and conveying units.

- A* 1½ inch steel angle iron on which brass rollers are secured for carrying the cassettes.
- BR* ⅝ inch brass roller.
- SL* Steel lug. A cassette is placed between two such steel lugs.
- LRC* ⅜ inch pitch roller chain for conveying the cassettes.
- SCC* Steel sprocket which powers the roller chain for conveying the cassettes.
- LA* Long arm of right angle bar of dog mechanism.
- SB* Steel block or cam for interrupting transmission of power to the drive shaft.
- MP* Metal pin in timing disc against which *LA* strikes to revolve the drive shaft.
- TD* Timing disc.
- DM* Dog mechanism on power sprocket.
- HC* Hand crank for adjusting steel lugs to permit proper placing of the first cassette in the loading bin.

Winfield H. Smith speed reducing unit No. 3½B (*RU*) slowing the speed in a ratio of 30:1. With the gear box operating at a constant and known speed, it was possible to calculate the size of the sprocket for the drive shaft of the reduction unit and that for the power sprocket (*PS*) (Fig. 4) of the conveyor system. The two sprockets were connected by a standard ⅜ inch pitch roller roller chain (*RC*).

On the drive shaft of the conveyor sys-

tem (Fig. 4) the following four devices were placed:

1. The power sprocket (*PS*) that receives the chain from the reduction unit. Note carefully that the axle for this sprocket is a separate housing surrounding and revolving independently of the drive shaft.
2. The timing disc (*TD*) 7½ inches in diameter for starting and stopping the cassette conveying system together with the

trigger mechanism for energizing the self-cocking Potter-Bucky grid.

3. The steel sprocket (*SCC*) $7\frac{1}{2}$ inches in diameter which powers the roller chain that moves and stops the cassettes.

4. The brake (*B*) to induce immediate

The movement of the power sprocket (*PS*) is transmitted through a dog mechanism (*DM*), a small right-angle steel bar that is secured to this sprocket by a single metal pin (*PDM*) at the angle of the bar. The long arm (*LA*) of the right-angle bar

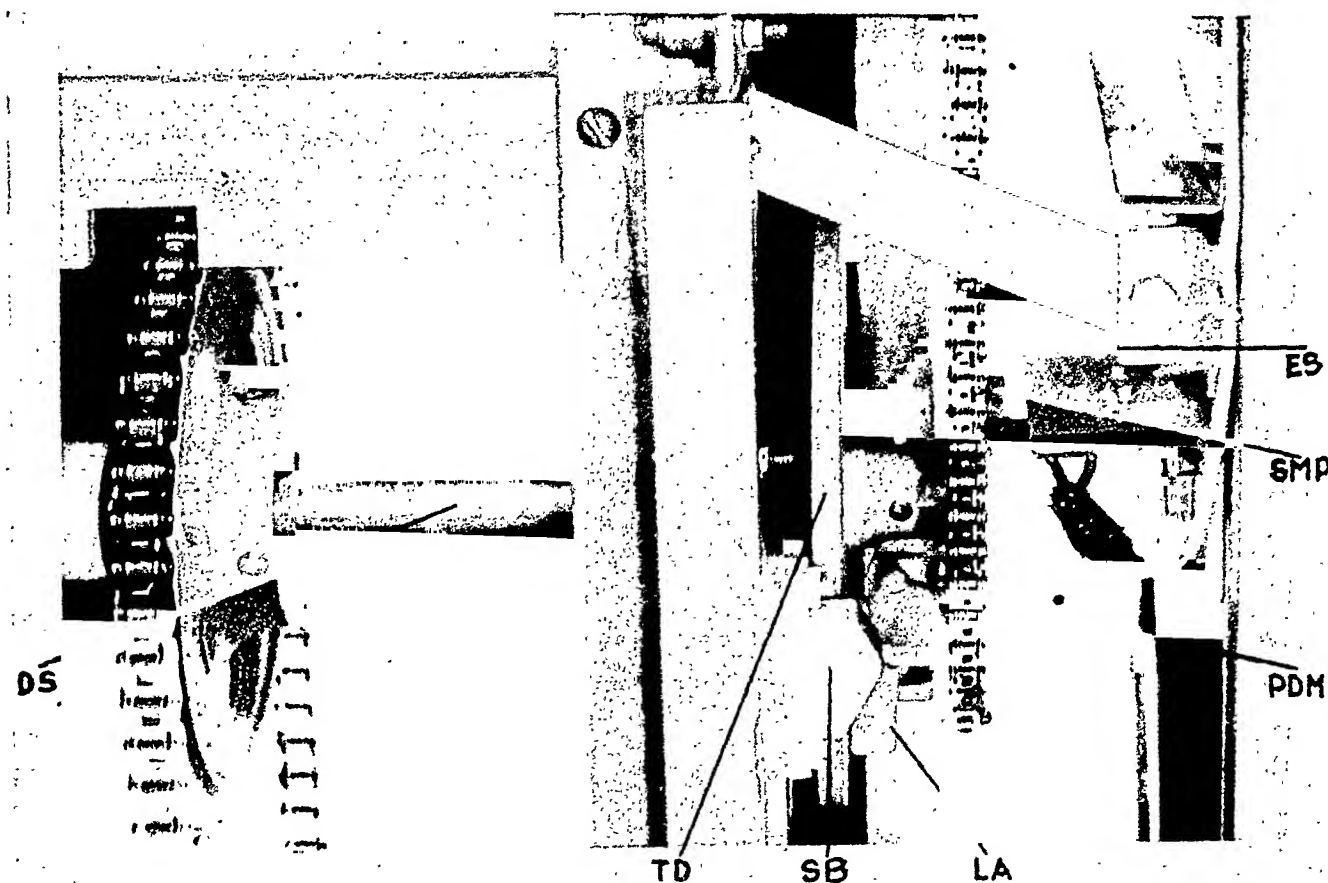


FIG. 6. Detailed vertical views of the timing mechanism.

- DS* Drive shaft.
- TD* Timing disc.
- SB* Steel block or cam for interrupting transmission of power to the drive shaft.
- LA* Long arm of right angle bar of dog mechanism.
- PDM* Metal pin placed through the long arm of the dog mechanism.
- SMP* Small metal pin on power sprocket which strikes electrical switch (*ES*) at the moment that the long arm (*LA*) of the dog mechanism (*DM*) becomes disengaged from the metal pin on the timing disc after it begins to move laterally on striking the steel block or cam (*SB*).
- ES* Electrical contact which is closed by the metal pin (*SMP*) to energize the Potter-Bucky diaphragm which in turn, by means of conventional electrical contacts starts the roentgen-ray exposure and shuts it off.

stoppage of the cassette conveyor system and for eliminating back-lash.

The power sprocket that is chained to the reduction unit revolves on a separate housing surrounding the main drive shaft of the conveyor system. This must be carefully noted as this arrangement is necessary in order to stop the conveyor system for the roentgen-ray exposures.

of the dog mechanism strikes one of three equally spaced metal pins (*MP*) on the timing disc immediately adjacent to it. As long as this arm of the angle bar is in contact with the metal pin of the timing wheel, the main drive shaft is revolving and the cassettes are in motion. With each revolution the long arm of the angle bar strikes a steel block or cam (*SB*) (Fig. 5 and 6)

fastened to the outside of the long arm of the angle iron (*A*). This steel block is roughly triangular in outline with the base secured to the angle iron and the apex directed toward the power sprocket. As the long arm (*LA*) of the angle iron strikes this steel block (*SB*) it is moved away from the timing disc (*TD*) and is thus disengaged from the metal pin (*MP*) on the timing disc.

the steel block again, which stops the conveyor system for the next roentgen-ray exposure.

At the same instant that the angle iron strikes the steel block to stop the conveyor system a small metal pin (*SMP*) (Fig. 6) on the outside of the power sprocket strikes an electrical switch (*ES*) to close the contact which energizes the Potter-Bucky grid

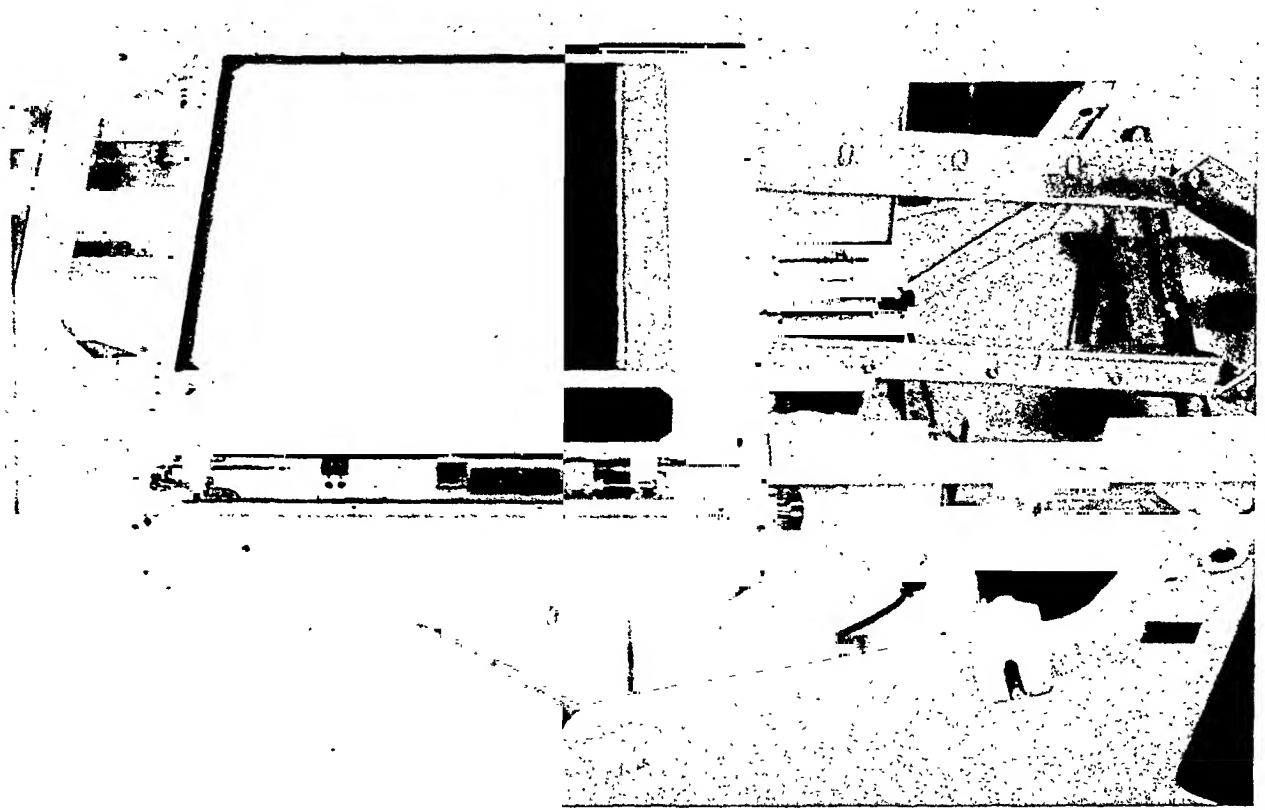


FIG. 7. Detailed view of the Liebel-Flarsheim self-cocking Potter-Bucky diaphragm. The top of the grid and the top of the table have been removed. The grid has been cut down and recentered to handle 11 by 14 inch cassettes instead of the 14 by 17 inch cassettes for which it was originally made.

This action interrupts the transmission of the motion from the power sprocket to the timing disc, and the conveyor system is halted for a brief instant ($\frac{1}{3}$ of a second) until the long arm of the angle iron has passed over the steel block and revolved far enough to strike the next metal pin on the timing disc. On striking the pin, motion is again imparted to the drive shaft and the conveyor system is set in motion until the pin makes a complete revolution and strikes

to start it on the down motion. The customary electrical contacts in the Potter-Bucky grid in turn start and shut off the roentgen-ray exposure.

The sprocket (*SCC*) which powers the roller chain for conveying the cassettes is secured to the drive shaft (*DS*). The opposite end of the roller chain revolves around an idling sprocket placed beneath the cassette bin at the extreme end of the table. Steel lugs (*SL*) are placed on the

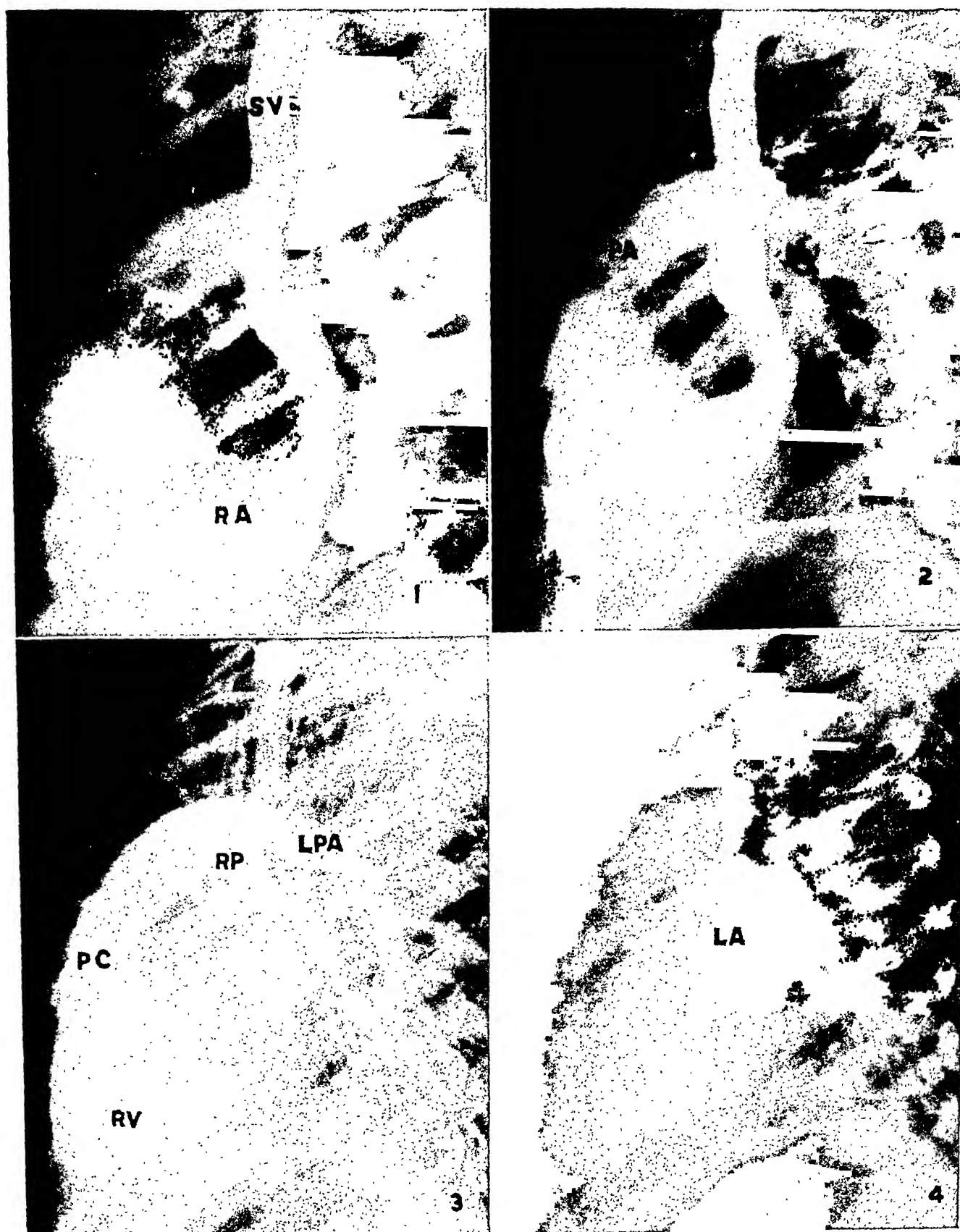


FIG. 8. Normal cardiovascular angiograms taken on the tautograph with the superior vena cava on the left side.

The routine examination includes a series of ten (11 by 14 inch) films made at one second intervals. The tautograph provides a continuous series of films demonstrating the transport of the diodrast through the chambers of the heart and the great vessels. Twenty cubic centimeters of seventy per cent diodrast was injected into the left antecubital vein with the child in the right posterior oblique position and the tauto-

roller chain at just sufficient intervals to permit an 11 by 14 inch cassette to be placed between them. The 14 inch dimension of the cassette parallels the chain.

Since the original photographs were made the brake (*B*) on the drive shaft has been widened to $1\frac{1}{2}$ inches to provide greater efficiency and smoother operation. It is simply a steel band covered with conventional automobile brake lining placed around a flat pulley on the drive shaft. An adjustable nut (*AN*) is available for tightening or reducing the efficiency of the brake as the occasion demands.

A hand crank (*HC*) (Fig. 5) with a ratchet device (*R*) was placed on the outside of the sprocket on the reduction unit so that the conveyor system could be moved by hand. It also serves to move the conveyor chain into the proper position for placing the first cassette between two of the steel lugs. The remaining cassettes are stacked in numbered sequence and drop down on the conveyor chain as soon as the next steel lug moves into place.

The retirement of the cassettes is provided for by tilting the end of the channel irons toward the floor so that the cassettes can slide by gravity to a partially sound-proofed receiving bin (*CRB*). The wooden receiving bin is lined with foam rubber to protect the frames of the cassettes.

The self-cocking Potter-Bucky grid is the

standard model made by the Liebel-Flarsheim Company except that the grid was cut down and recentered to conform to an 11 by 14 inch cassette. In our experience this grid adds desirable contrast to the films and is worth the additional expense. In all children and infants the roentgen-ray exposure is reduced to $1/20$ of a second and in most adults to $1/15$ of a second although $1/10$ of a second is required for large patients.

A rotating anode tube is used for greater definition. All the power that is available is desirable. We use 500 milliamperes, 65 to 100 kilovolts with exposure times of $1/10$, $1/15$, or $1/20$ second.

Figures 8, 9, and 10 are a series of ten films made on the tautograph at one second intervals. These films, taken in rapid sequence, demonstrate the progress of the opaque chemical through the chambers of the heart and great vessels. The advantage of this procedure is apparent from an examination of the films. The technical quality has been greatly enhanced by incorporating the self-cocking Potter-Bucky grid and synchronizing it with the roentgen-ray exposure. Originally we felt these children had to be anesthetized, but subsequent experience has shown that most of them can be satisfactorily handled by giving a little phenobarbital to the older children a short time before the examina-

graph horizontal. The films were made at a rate of slightly less than one per second and with a self-cocking Potter-Bucky grid synchronized with the exposure.

This case is a boy aged five and a half. He was well developed and never cyanotic. He had a systolic murmur over the precordium and further studies suggested that he might have an aortic or subaortic stenosis, but these possibilities were ruled out by angiography. The progress of the diodrast is well demonstrated and can be followed through the cardiovascular circulation by consecutive examination of the films. The following abbreviations designate the different chambers and great vessels.

*SV*C—Superior vena cava

RA —Right auricle

RV —Right ventricle

PC—Pulmonary conus

LA—Left auricle

LV—Left ventricle

BA —Bulbus arteriosus

LPA—Left pulmonary artery

RP —Right pulmonary artery

Film 1. The diodrast is in the superior vena cava, the right auricle, and right ventricle and is entering the pulmonary conus.

Film 2. The right ventricle and pulmonary artery are better filled.

Film 3. The right ventricle is now completely filled and the contrast medium has progressed into the pulmonary arteries.

Film 4. The diodrast is returning through the pulmonary veins, is filling the left auricle and a small amount has entered the left ventricle.

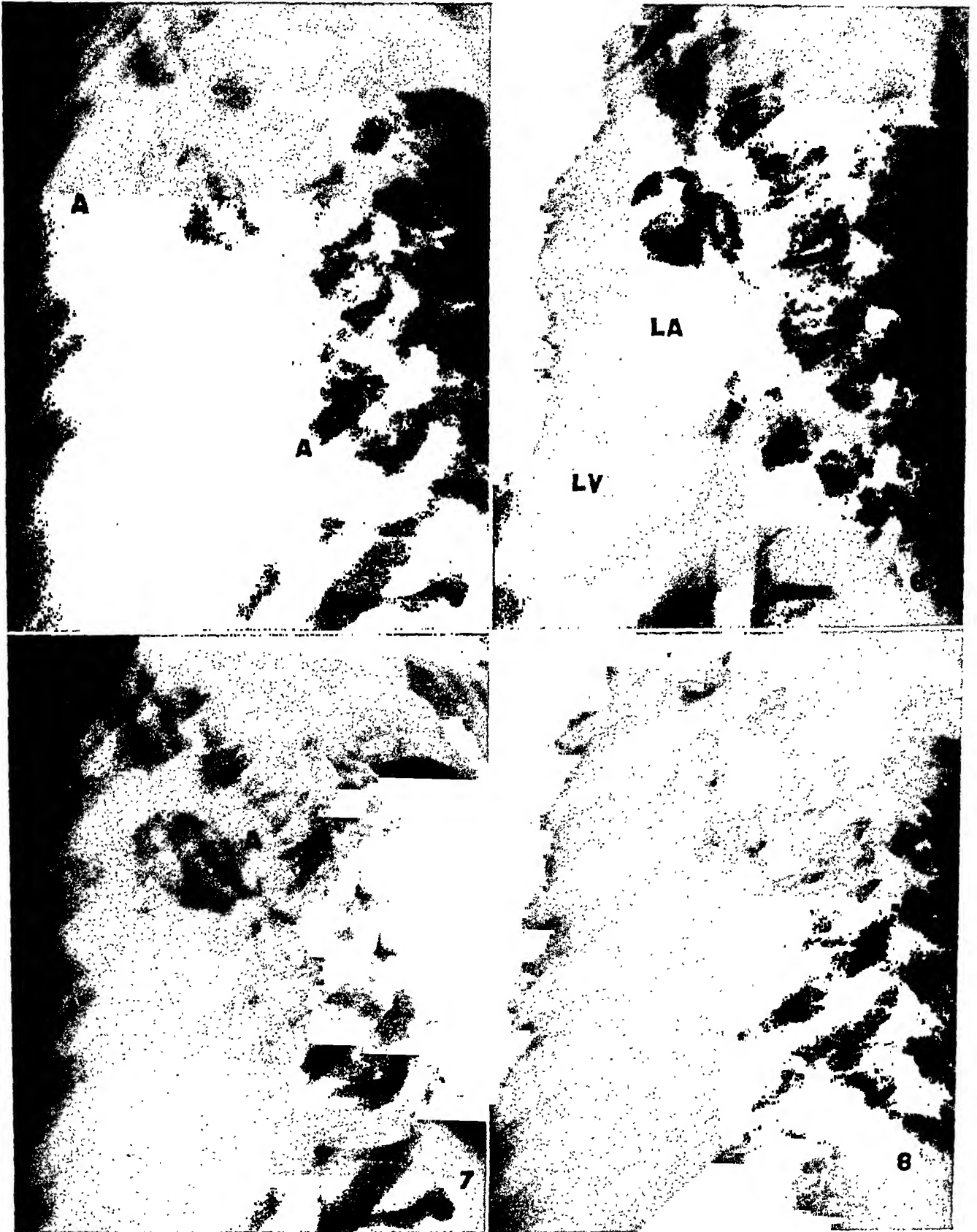


FIG. 9. Film 5. The opaque material has been injected into the aorta and is filling the major branches ascending in the neck.

Film 6. The left auricle and left ventricle and the aorta with its major branches are visualized at maximum density. Note the bulbus arteriosus and the coronary arteries below the letters *BA*.

Film 7. The density of the opaque material is beginning to fade out as it becomes diluted by the blood.

Film 8. Practically all of the diodrast has left the heart while a little remains in the aorta.

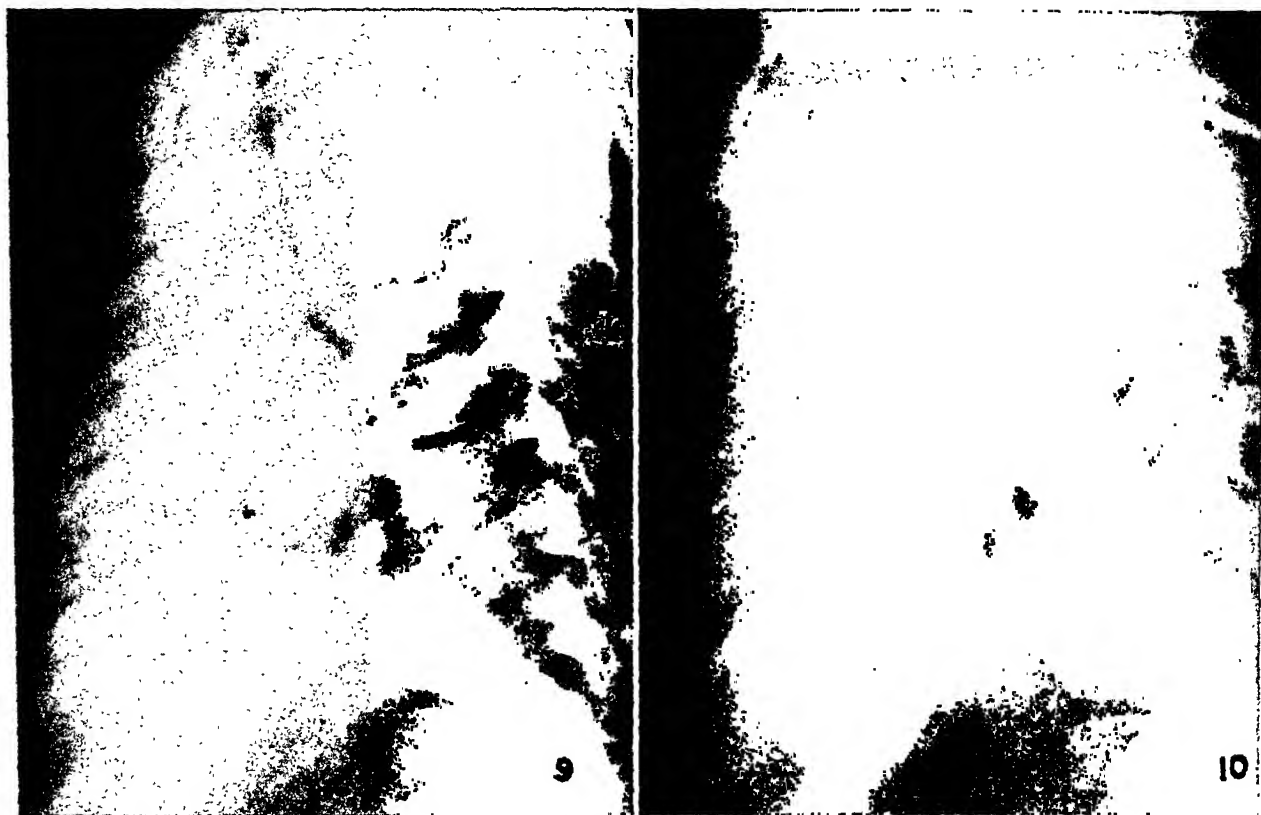


FIG. 10. Film 9. All the diodrast has passed into the systemic circulation and none remains in the cardiopulmonary circuit.

Film 10. A small amount of the opaque medium is returning from the systemic circulation into the superior vena cava. It is not sufficiently dense to be of clinical significance.

tion and by giving the younger children and infants a little sugar water in a bottle for them to suckle on during the examination.

CONCLUSIONS

(1) The tautograph offers a new principle in rapid serial roentgenography by utilizing a chain conveyor system for standard cassettes, by the incorporation of a self-cocking Potter-Bucky grid, and by the complete automatization of the entire

equipment.

(2) Rapid serialization of roentgen-ray exposures by the full automatization of the equipment makes angiocardiology a practical technique in the diagnosis of infants and children with congenital heart disease.

(3) The technique has also been used to advantage in cerebral angiography.

510 South Kingshighway Blvd.
St. Louis 10, Mo.



PULSATING EXOPHTHALMOS DUE TO DEFECTIVE DEVELOPMENT OF THE SPHENOID BONE

By E. GRAEME ROBERTSON

MELBOURNE, VICTORIA, AUSTRALIA

UNILATERAL pulsating exophthalmos due to defective development of the bony wall of the orbit is a rare condition. Martin and Mabon⁵ do not mention this cause in a "review of all reported cases," 812 in all, of pulsating exophthalmos. The condition has characteristic features and its recognition obviates the possibility of misguided treatment. The words of LeWald⁴ may appropriately be quoted: "The recognition . . . is of extreme importance in roentgen diagnosis.

"In the first case which I observed in 1926 a previous erroneous diagnosis of sarcoma of the orbit with destruction of the orbital bony structures had been made, and the advisability of enucleation of the eyeball had been discussed. In a somewhat similar case reported by Rockliffe and Parsons actual removal of the orbital contents preceded by ligation of the carotid artery was performed and was followed by the death of the patient."

The condition was first described clearly by Dandy.³ His patient was an intelligent girl of sixteen, who had had pulsating exophthalmos from birth. Roentgenograms showed that the posterior half of the roof of the orbit was missing. Dr. Arnold Knapp of New York, after a study of the roentgenogram, had suggested that this was a congenital defect. During a reparative operation, Dandy found the outer surface of the brain to be covered by large pools of fluid in the subarachnoid space; the leptomeninges were opaque and greatly thickened. The posterior two-thirds of the orbital roof was absent. There was no anterior clinoid process. The bony defect was covered by dura, which was firmly attached to the eyeball. The tip of the temporal lobe was covered by tremendously dilated subarachnoid spaces, continuous through the sylvian fossa with similar spaces over

the frontal and parietal lobes. A large anomalous vein lay medial to the dura on the inner side of the middle cranial fossa. It represented the extradural cavernous sinus and was formed by the confluence of two large veins, the superior and inferior orbital veins, which pierced the dura covering the orbital contents. The carotid artery was not seen. Dandy inserted a piece of the outer table of the skull of proper shape, curvature and size into a tunnel between the dura and the orbital contents, so that it rested on bone on each side and in front. The patient benefited from the operation. Slight downward displacement of the eyeball remained, but there was no exophthalmos or pulsation of the eyeball. There was no diplopia five months after operation, although it is to be remembered that the vision of the left eye was poor (6/60) before operation and, after operation, the eye was reported to deviate downwards and inwards.

LeWald⁴ described 4 cases (including that described by Dandy) with pulsating exophthalmos, in which roentgenography of the skull disclosed absence of the roof and posterior walls of the orbit. The anterior clinoid process was absent on the affected side. The orbit was enlarged, and its inferior wall depressed, so reducing the size of the maxillary antrum. The vision was variably affected. In 2 of the 4 cases there was evidence of diffuse neurofibromatosis, and 1 had other developmental defects, namely abnormal cervical vertebrae and an arteriovenous fistula of the leg. LeWald reviewed the literature and found several cases, described under varying diagnoses, which he considered to be examples of this condition. Of much interest were 4 cases reported by R. F. Moore,⁷ in which pulsating exophthalmos was associated with diffuse neurofibromatosis. This association

prevented a clear statement of what was undoubtedly in the author's mind—that the bony defect was, in reality, a developmental one. Referring to a pathological report of a case by Rockliffe and Parsons, Moore stated that he suspected that the bone had never developed. In describing the pathological examination of this case, which was associated with a large plexiform neuroma of the orbit, Rockliffe and Parsons⁹ reported that "the crista galli and central dividing crest of the parietal bone were pushed nearly one inch to the left of the median line. The whole of the orbital plate of the frontal, the lesser and greater wings of the sphenoid, and the lacrymal plate of the ethmoid were missing, and the inner margin of the supra-orbital ridge was serrated. The roof of the orbit was represented only by thickened dura mater. . . ." It is also interesting to note that, in a discussion of this case when it was originally shown by Rockliffe, Clarke² stated that he had demonstrated a patient in 1894, whose history left little doubt that the lesion was a developmental defect.

Anderson,¹ in a monograph entitled "Hydrophthalmia or Congenital Glaucoma," devoted a section to the association of congenital glaucoma with other anomalies, including von Recklinghausen's disease. He mentioned a number of authors who had described cases in which pulsation of the eyeball due to a defect in the orbital wall was also present, sometimes together with "elephantiasis of the lids." In some of these cases there was prominence of the temporal region and enlargement of the sella turcica. Apparently in most cases the condition was thought to be due to erosion of bone by a neurofibromatous mass, but some authors appear to have suspected that the co-existence of the two conditions was rather due to the tendency of development defects to occur together. More recently, A. E. Moore⁶ described 2 cases in which neurofibromatosis was associated with proptosis and a defect of the orbital wall. Wheeler,¹¹ in describing the cases which he had seen in conjunction with LeWald,

states: "Pulsation of the eyeball may depend upon communication between the cranial and orbital cavities, but pulsation probably does not occur unless a large part of the roof of the orbit is absent. Such a large defect may be (a) a congenital anomaly, an arrest of development, (b) an accompaniment of plexiform neurofibromatosis of the orbit (von Recklinghausen's disease) and in this condition the bony defect may be congenital, (c) a result of surgical removal of the roof of the orbit. Pulsation may be lost in a quantity of neurofibrous tissue between the orbito-cranial communication and the dislocated eyeball."

CASE REPORT

A Warrant Officer, aged thirty-seven, stated that since he was fourteen years of age he had noticed "slight enlargement and slight movement" of his left eye. He suffered no inconvenience until three years before when working in a hot dusty atmosphere he developed conjunctivitis, which persisted for two years in spite of treatment. Some months after the onset of the conjunctivitis he began to suffer from intermittent pains which seemed to start in the center of his eyes, and extend through to the back of the head. The pain was worse on the left side than on the right. It became more frequent and severe during a period of hard work some two and a half years after its onset. The pain was of gnawing quality, and was not influenced by posture. Although the pain did not throb, he was conscious of pulsation, which was especially rapid when he was excited.

The left eyeball was prominent and depressed. There was deliberate backward and forward movement of the left eyeball, synchronous with the pulse. The amplitude of this movement with each pulse beat was slightly less than 1 mm. There was also a slower and less obvious variation, synchronous with respiratory movement and having an amplitude of about 0.75 mm. Compression of the jugular veins caused further protrusion of the eye. Compression of the left carotid artery lessened the amplitude of the pulsation, while bilateral compression abolished it. The eyeball was readily displaced backwards by pressure on the closed eyelids. The eye sank deeply into the orbit, beyond a normal position, until eventually con-

siderable discomfort resulted. No bruit was audible. The fundi were normal. The retinal veins on the left side were of the same diameter as those on the right. The visual acuity of each eye was good and equal and the visual fields were normal. The skull was of brachycephalic type, the left temporal region being more prominent than the right.

Roentgenological examination of the skull showed slight enlargement of the left orbit with depression of the inferior wall, the maxillary antrum being smaller on this side (Fig. 1). The left orbit had an appearance of uniform trans-

(Fig. 2). Roentgenograms of the base of the skull showed normal foramina ovale and spinosum on the right side. On the left side there was a single large foramen which opened widely into the foramen lacerum.

The initial pressure of the cerebrospinal fluid was 170 mm. Bilateral jugular compression caused a rapid rise to 550 mm., with a rapid fall on release of pressure. Pressure on the right jugular vein alone caused a rise to 480 mm., while pressure on the left caused a rise of only 50 mm. Pressure on the left eye caused a rise of 25 mm. within two seconds, followed by a

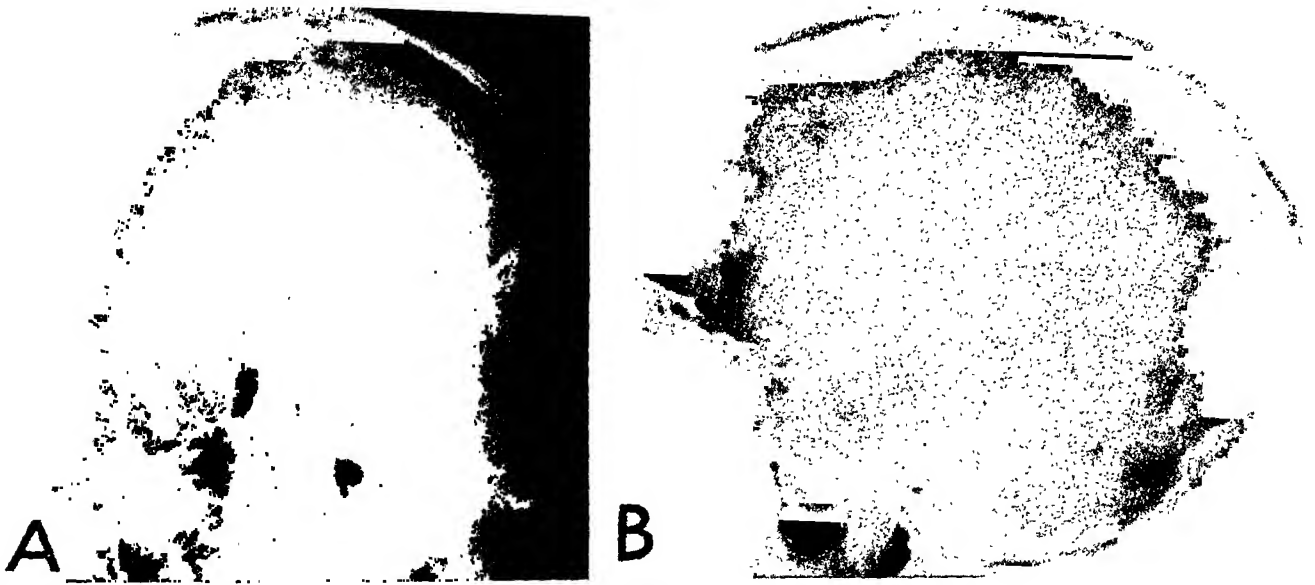


FIG. 1. Posteroanterior (*A*) and lateral (*B*) roentgenograms showing the absence of the roof of the orbit and the posterior orbital wall on the left side.

lucency in axial films, and, in contrast to the normal side, no shadows were seen corresponding to the orbital plate of the frontal bone, the lesser wing of sphenoid, or the orbital plate of the greater wing. The zygomatic process of the frontal bone and the frontal process of the zygomatic bone were wider on the left side. There was a large frontal extension of the posterior ethmoidal cells, and the ethmoidal cells medial to the left orbit were narrow. The left lateral wall of the sphenoidal sinus was closer to the median line than the right. An area of thinning was seen in the frontal bone above the lateral part of the zygomatic process. Lateral views (Fig. 1*B* and 5*B*) showed a large pituitary fossa, with a straight anterior wall. The orbital plate of the frontal bone terminated 7 mm. behind the ethmoidofrontal recess. A normal optic foramen with a large pneumatized anterior clinoid process was seen on the right side, while on the left side the corresponding structures were absent

slower rise to 380 mm. in ten seconds. Further pressure at this stage produced considerable discomfort which, on each occasion, necessitated release of pressure. The pressure of the fluid fell rapidly to the original level when the pressure on the globe was released. The rise of pressure was undoubtedly due to an increase in the bulk of the intracranial contents. The cellular and chemical constituents of the fluid were normal (the protein content amounting to 20 mg. per 100 cc.).

Encephalography was performed in an endeavor to obtain further information. The lateral ventricles were slightly enlarged. The right anterior horn was larger than the left, and the tip of the left temporal horn was considerably larger than the right. The septum pellucidum was situated to the left side of the midline. The cerebral sulci were wider than normal. A collection of gas was seen in the left orbit. In the anteroposterior view (Fig. 3*A*) it was seen below

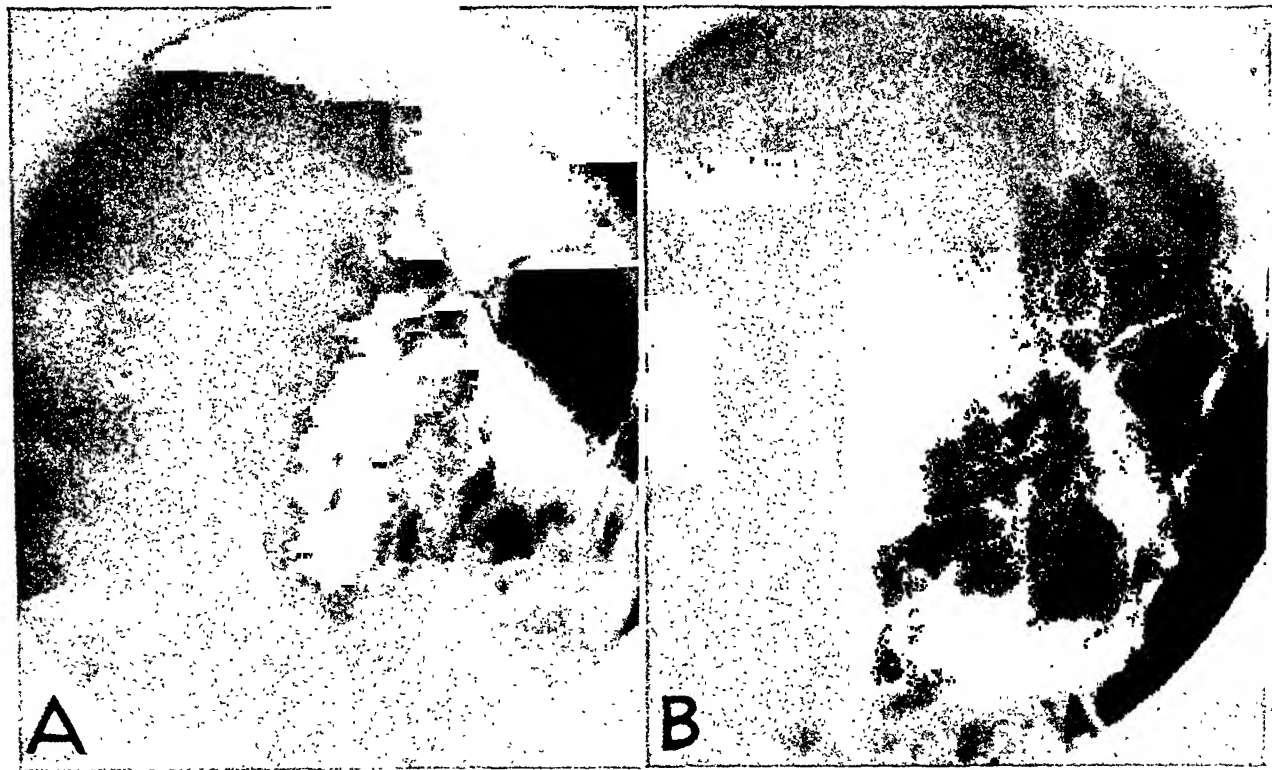


FIG. 2. Orbital films to show the optic foramen on the right side (A) and its absence on the left (B).

the level of the superior orbital margin, extending across the width of the orbit. The upper part of the shadow was indented, apparently by the convolutions of the inferior surface of the frontal lobe. A lateral film (Fig. 3B) showed the gas to extend forward to the posterior surface of

the eyeball. These findings suggested the presence of an orbital encephalocele, due to defective development of the orbital wall. Subsequent inquiry from the patient's mother elicited the fact that the deformity had been noticed soon after birth. On the day after en-

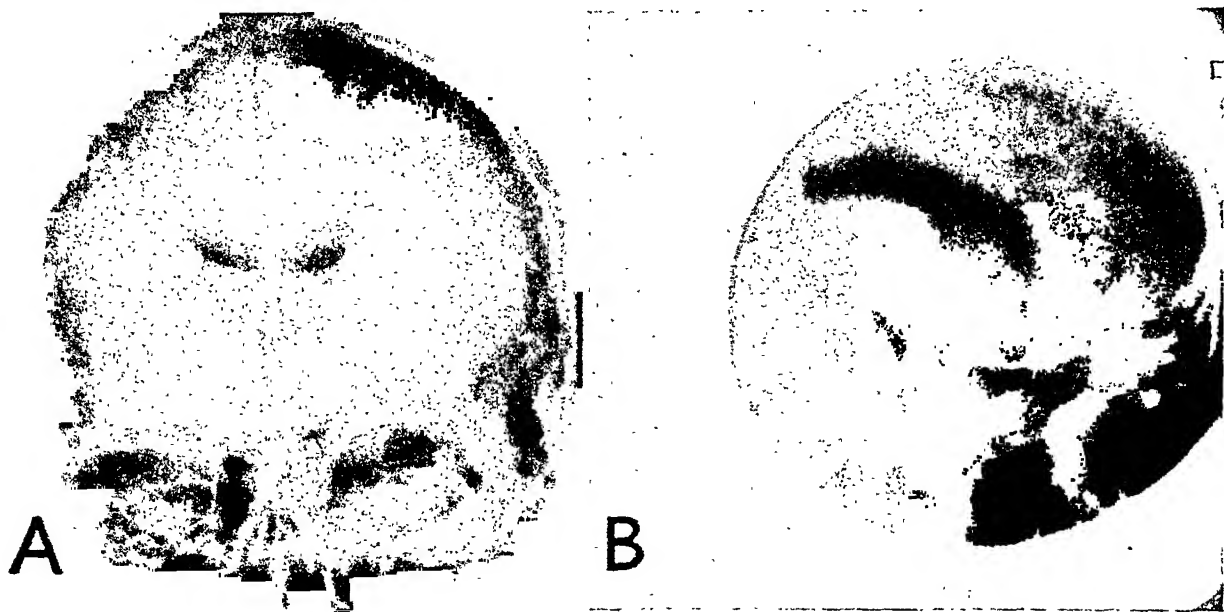


FIG. 3. Anteroposterior (A) and lateral (B) films taken with the brow up after a limited replacement of cerebrospinal fluid with oxygen. The subarachnoid space on the left side is seen to extend into what is normally the orbit. The large pituitary fossa and the defect in the roof of the orbit is seen in (B).

cephalography the left eye was less prominent than the right, although it still pulsated, and there was troublesome diplopia. Jugular compression temporarily restored the exophthalmos. The eye gradually became more prominent, although at the end of ten days the proptosis remained less pronounced than before encephalography.

Laminagrams showed that the floor of the middle cranial fossa was lower on the left side than on the right, especially anteriorly (Fig. 4).



FIG. 4. Laminagram in the coronal plane of the right clinoid process. The left clinoid process is absent. The asymmetrical body of the sphenoid, the depression of the floor of the middle fossa and the bulging of the temporal fossa are seen. The pterygoid processes are wider apart on the left side and the medial process more slender.

On the left side this part of the floor (formed by the greater wing of the sphenoid) turned upwards into the temporal surface without the broadening caused by the confluence of the orbital portion, which could be seen on the right side. Asymmetry of the sphenoidal sinus was evident, as was the absence of the anterior clinoid process on the left side. Sphenoidal cells extended into the base of the lesser wing on the right side and into the right anterior clinoid process. The pterygoid processes appeared to be more delicate on the left side than on the right. More posteriorly, on the left side, the foramen ovale could not be separated from the large foramen lacerum. In more anterior sections, the roof of the orbit was seen to be absent on the left side. The lesser wing of the sphenoid on the right side was unusually delicate. The floor of the ethmoidal recess and of the left frontal sinus was thin. Laminagrams taken parallel to the sagittal plane showed the deformity in con-

trast to the conformity of the normal side (Fig. 5). It will be seen that the posterior part of the orbital plate of the frontal bone, the lesser wing of the sphenoid and the vertically directed orbital part of the greater wing were absent.

Finally, it may be stated that the patient's headache disappeared during his stay in the hospital and has not returned since. He states that his eye is "smaller and more balanced than before." In the absence of discomfort it seemed unnecessary to suggest operative treatment. A further deterrent was the possibility of inducing diplopia, which might persist if the proptosis were abolished.

DISCUSSION

The accepted descriptions of ossification of the sphenoid bone afford no clue to the pattern, and the constancy of pattern, of the defect. The greater wing, including the lateral pterygoid lamina, is said to ossify as a whole. The lesser wing and the medial pterygoid processes have separate centers, and all unite with the body which develops from multiple centers. It is possible that, in reality, the orbital plate has a separate center of ossification.

The pituitary fossa is abnormal in size and shape in all the recorded cases; sometimes it is described as being deep, sometimes wide and shallow. It seems likely that this is due to maldevelopment of the fossa, rather than to an enlargement of the pituitary gland. No gas passed into the fossa during encephalography, but this does not exclude the presence of a large diverticulum of the subarachnoid space. The defective orbital plate of the frontal bone may be of primary significance, indicating that the defective development is due to some regional cause affecting all the bones in this region. On the other hand, it is more probable that the orbital plate fails to develop because of the absence of the lesser wing of the sphenoid, with which it articulates. The bulging temporal fossa, which is a constant finding, may be due to the absence of the retaining tie provided by the lesser wing of the sphenoid and the orbital plate of the frontal bone.

The dural membrane rests in equilibrium



FIG. 5, *A, B, C, D*. Laminagrams in the sagittal plane. The contrast between the right (*A*) and left orbits (*C* and *D*) is well seen. A midline film (*B*), showing the deep sella turcica, is included for contrast.

when the pressure inside is equal to that outside. The pulsation is a visible expression of the fluctuation of the intracranial pressure. O'Connell⁸ has calculated that the fluctuations due to cardiac and respiratory activity probably each lie between 20 and

60 mm. of fluid. Pulsation would be reduced were the dura mater tightly stretched over the aperture, particularly if the latter were small, or if an inelastic block of tissue existed between the dura and the eye. The first factor is probably sufficient to

explain the slight or absent pulsation after operative removal of the roof of the orbit, and the last, when neoplastic tissue intervenes. Pulsation has been observed in the dura after enucleation of the eye following an extensive comminuted fracture of the roof and posterior orbital wall. If the roof and posterior wall of the orbit are absent, the dura is able to prolapse into the orbit, for it no longer extends over two sides of a triangle, with a right angle bend at the lesser wing of the sphenoid (Fig. 5). The laxity of the dura under these conditions permits the transmission of the intracranial pulsation to the orbit.

Under the title "Pathogenesis of Intermittent Exophthalmos," Walsh and Dandy¹⁰ describe a condition characterized by pronounced and rapid protrusion of one eye when venous stasis is induced by obstruction of the jugular veins. The eyeball may pulsate, and progressive failure of vision, pain and diplopia occur. Although they found descriptions of 111 cases, the cause had previously remained undiscovered. Exploration disclosed a mass of coiled vessels in the region of the sphenoidal fissure and the anterior part of the middle cranial fossa. They suggested that enlarged veins drained the aneurysm through the orbit, which itself was free of aneurysm. The size of these vessels would vary with the freedom of flow of blood through the jugular veins. Obstruction would cause distention of the large veins within the orbit, which would immediately cause proptosis. They considered that this was the only condition which could produce intermittent exophthalmos. It is interesting to note that enophthalmos, giving place to proptosis on jugular compression, existed in the patient described after encephalography. However, this was a transient state of affairs, occurring only when the intracranial pressure was artificially lowered. The presence of enophthalmos for some days after encephalography suggested that the fall of pressure was due to escape of cerebrospinal fluid through the puncture in the spinal membranes. It is interesting to note

that the patient suffered no headache at this time (in contrast to the severe headache experienced when a fall of pressure follows lumbar puncture), probably because of the compensation effected by retraction of the orbital contents.

The condition is so characteristic that a mistake in diagnosis is unlikely, once the condition is known. The absence of distressing symptoms, the slow deliberate type of pulsation and the absence of bruit differentiates it from unilateral exophthalmos due to arteriovenous aneurysm. In the latter, pulsation is less marked and there is usually marked dilatation of the retinal and neighboring veins.

The result of the developmental defect may be properly termed orbital meningocele and encephalocele, but it differs from the better known condition to which these terms usually are applied. In the latter, the roentgenological picture is entirely different, for the sac usually escapes from the cranium through a gap between the cribriform plate of the ethmoid and the orbital plate of the frontal bone, and protrudes into the orbit between the latter and the lamina papyracea of the ethmoid. As the defect is usually situated anteriorly in the orbit, the eye is displaced laterally and downwards but is not unduly prominent.

The writer desires to express his gratitude to Major-General S. Roy Burston, Director-general of Medical Services, Australian Military Forces, for permission to publish this paper. Colonel D. J. Thomas, Commanding Officer, 115 (Heidelberg) Military Hospital, personally provided the facilities for taking the laminagrams.

33 Collins St.
Melbourne C. 1
Victoria, Australia

REFERENCES

1. ANDERSON, J. R. *Hydrophthalmia or Congenital Glaucoma*. Cambridge University Press, 1939.
2. CLARKE, E. Discussion on paper by Rockliffe, W. C. Pulsating exophthalmos (congenital). *Tr. Ophth. Soc. United Kingdom*, 1900, 20, 170.
3. DANDY, W. E. An operative treatment for certain cases of meningocele (or encephalocele) into orbit. *Arch. Ophth.*, 1929, 2, 123-132.

4. LEWALD, L. T. Congenital absence of superior orbital wall associated with pulsating exophthalmos; report of 4 cases. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1933, 30, 756-764.
5. MARTIN, J. D., JR., and MABON, R. F. Pulsating exophthalmos; review of all reported cases. *J. A. M. A.*, 1943, 121, 330-335.
6. MOORE, A. E. Neurofibromatosis associated with proptosis and defect of orbital wall. *Australian & New Zealand J. Surg.*, 1936, 5, 314-318.
7. MOORE, R. F. Diffuse neurofibromatosis with proptosis. *Brit. J. Ophth.*, 1931, 15, 272-279.
8. O'CONNELL, J. E. A. Vascular factor in intracranial pressure and maintenance of cerebrospinal fluid circulation. *Brain*, 1943, 66, 204-228.
9. ROCKLIFFE, W. C., and PARSONS, J. H. Plexiform neuroma of orbit. *Tr. Path. Soc. Lond.*, 1904, 55, 27-38.
10. WALSH, F. B., and DANDY, W. E. Pathogenesis of intermittent exophthalmos. *Arch. Ophth.*, 1944, 32, 1-10.
11. WHEELER, J. M. Pulsation of eyeball associated with defects in wall of orbit. *Bull. Neurol. Inst. New York*, 1936, 5, 476-484.



SOLITARY TUMORS OF THE CHEST*

THE DIFFERENTIAL DIAGNOSIS IN FIFTY PROVED CASES

By ROBERT K. ARBUCKLE, M.D.

OAKLAND, CALIFORNIA

THE number of tumors of the chest coming to the attention of roentgenologists has increased since the beginning of mass surveys. These cases have been selected only to the extent that the roentgenologist reporting the first film study was unable to differentiate between two or more of the following tumors: *teratomas, aneurysms, intrathoracic thyroid, carcinoma* (primary or metastatic), *one of the lymphoblastomas*, and so forth. Although the tumor was discovered in 9 patients of this group during a survey, no attempt was made to arrive at an exact diagnosis until a complete roentgenographic study had been carried out.

The purpose of this study was to determine which of the diagnostic studies offer the most help in arriving at an exact diagnosis in patients who present a solitary tumor of the chest.

STUDIES COMMONLY MADE

A. Roentgenoscopy of the Chest. This important diagnostic study should be employed routinely. The vocal cords should be studied both while at rest and during phonation. The detection of a paralyzed left vocal cord in a patient who has a mass along the left anterior mediastinum is important. Aneurysms of the arch of the aorta frequently cause a paralysis of the left recurrent laryngeal nerve. If the mass is above the aorta and is associated with a paralysis of a vocal cord, there is great likelihood that we are dealing with an invasive neoplasm. A tumor associated with an elevated leaf of the diaphragm, with paradoxical motion, is most likely involving the phrenic nerve.

An attempt should be made to separate the mass from the heart and great vessels.

Rotation of the patient, while roentgenoscopic observations are made, will frequently make this differentiation possible. In some instances it will not be possible to confirm or rule out the possibility of a mass having originated in the heart or aorta.

The presence or absence of pulsation of the mass should be observed. The significance of these pulsations is questionable. Pulsations have frequently been accepted as presumptive evidence of the mass being an aneurysmal sac. This has resulted in numerous errors. I believe pulsation of the aneurysmal sac to be the exception rather than the rule. The most vigorous pulsations are noted when a solid tumor rests against a normal aorta. A diseased dilated aorta containing a thrombus is rarely capable of exhibiting vigorous pulsations, due to the inelasticity of its walls. Palpation of an accessible aneurysm frequently fails to reveal pulsations. In both of the innominate artery aneurysms in this series, careful repeated examinations by several examiners failed to detect the presence of pulsations. In some patients it is difficult to determine whether the mass is within the lung or in the pleural space. Close observation of the filling and emptying of the adjacent lobe will usually make this distinction possible. A mass which appears to be against the posterior chest wall might be displaced forward by air-containing lung behind it, if it is within the lung. The presence or absence of obstructive emphysema might also aid in this differentiation.

Studies of the barium-filled esophagus frequently give information concerning the exact location of the mass.

B. Roentgenographic Study. In addition to the conventional ventral and lateral projection films, a Potter-Bucky film is

* From the Department of Radiology, Temple University Hospital, Philadelphia, Pennsylvania.

usually made. This assures a more adequate penetration of the mass, and affords us more accurate information concerning the presence or absence of calcium, uniform density, erosion of the adjacent bones, and so forth. If the mass is along the course of the esophagus, we have found films with the esophagus outlined by barium to be of considerable help.

All of the roentgenograms have been reviewed with particular reference to the following points:

(a) *Bone erosion.* None of the aneurysms showed evidence of bone erosion. In instances of erosion of the spine or of the sternum by a contiguous mass suspected of being an aneurysm, the diagnosis is relatively simple. Two of the nerve tissue tumors were of the "collar button" variety with one mass situated in the thorax and the other within the neural canal. They were joined by a narrow neck through an intervertebral foramen. In neither instance was there evidence of widening of the foramen or erosion of the adjacent bony structures, as observed by the roentgenograms and at exploration. Some of the large nerve tissue tumors rested against the posterior rib cage and dorsal vertebral bodies but there was no evidence of erosion observed at the time of operation or on the films. One of the tumors of nerve tissue origin determined to have undergone sarcomatous degeneration was later discovered to have metastasized to a vertebral body.

(b) *Presence of calcium.* The presence of calcium when in the form of bones or teeth establishes the tumor as belonging to the teratoma group. Relatively few teratomas show a calcium deposit. In the present group of cases calcium was found in 4 instances (carcinoma of the thyroid, wall of a bronchiogenic cyst, a thymoma and a neurofibroma with sarcomatous degeneration), and in none of the cases was it of help in establishing the diagnosis. When calcium is deposited within the walls of an aneurysmal sac it helps in establishing this diagnosis but in most aneurysms calcium cannot be detected.

(c) *Location of the mass.* It is commonly said that tumors of nerve tissue origin are found in the posterior part of the thorax but not anteriorly. We have found the neurofibromas in both the anterior and posterior parts of the thorax. Both of the ganglioneuromas were in the posterior gutter against the spine. Aneurysms are usually located anteriorly on the right and posteriorly on the left. In the present group of cases we have tabulated both exceptions. We find the serologic and neurologic findings of greater help in confirming or ruling out the diagnosis of an aneurysm than the location of the mass. One of the thymomas was so far from the normal thymus gland site that the diagnosis seemed unlikely but sections made from all parts of the tumor substantiated the diagnosis.

(d) *Effect on the adjacent structures.* The lack of bone erosion was mentioned above. Tracheal compression has been found due to carcinomas and aneurysms. Apparently this is due to the normal fixation of the aortic arch and innominate artery so that compression rather than displacement of the trachea occurs. The carcinomas which invaded the mediastinum also fixed and compressed the trachea. In several instances fixation of the trachea was detected by the bronchoscopist before there was roentgen evidence of compression. The teratomas, cysts, Hodgkin's disease, lymphosarcoma, tumors of nerve tissue origin and thymomas did not produce tracheal or vascular compression even when situated adjacent to the trachea and great vessels.

(e) *Pleural effusion.* Free fluid in the pleural space was found in 2 patients. In 1 patient 2,000 cc. of grossly bloody fluid was removed. At a subsequent exploration a spherical tumor (benign neurofibroma) was readily removed. The second patient whose roentgenograms appeared identical showed clear fluid with an abundance of tumor cells. Subsequently pleural metastases were detected.

C. *Bronchoscopy.* This diagnostic measure which contributes so much in most pulmonary diagnostic problems affords

little help in tumors of this nature. The detection of a paralyzed vocal cord, fixation of the trachea, compression of a bronchus, and so forth, have value in determining the operability of the tumor but afford little positive diagnostic information. In only 2 cases of this group was the bronchoscopist able to secure a satisfactory specimen for histologic study.

D. Sputum Study. The detection of hair or sebaceous material is of great value in establishing the diagnosis of a dermoid. The presence of neoplastic cells is of value in establishing the diagnosis of a malignant tumor. We have used this study in only a few cases of this series but there is evidence to suggest that a more routine search for the presence of tissue cells is warranted.

E. Planigraphy, thoracoscopy and lipiodol bronchography have not afforded us help in the differential diagnosis of these tumors.

F. Histopathologic Study of Aspirated Pleural Fluid Cells. Pleural fluid was present in 2 of these cases. In 1 patient who had clear fluid a definite diagnosis of adenocarcinoma was made. The other patient had 2,000 cc. of *bloody fluid* removed and this revealed no abnormal cells. At a subsequent exploration an 8 centimeter spherical tumor was removed from the pleural space and was found to be a neurofibroma. There was no evidence of neoplastic changes and the tumor was not adherent. The blood vessels over the capsule of this tumor were profuse and the area showed changes indicating the site of the bleeding. This patient had a history of intermittent attacks of pleurisy for seven years. Bloody pleural fluid is not always indicative of a malignant tumor of the pleura and should not contraindicate exploration.

G. Response to Irradiation. A test of response to the effects of irradiation is of value in some of the patients in whom a diagnosis cannot be made by aspiration biopsy, or in whom a tumor of the lymphoblastoma series cannot be excluded. The disadvantages are: (1) the length of time that must elapse before conclusions can be reached (two to three weeks), (2) malig-

nant tumors of a resistant type cannot be excluded by this method. Benign tumors are not influenced by the irradiation. We have given a course of irradiation to masses, ultimately determined to be aneurysms, without any harmful results to the patient. This test is of practical use in some of those masses which can be definitely localized to the mediastinum.

H. Hormone Assay. The Aschheim-Zondek or similar tests have not been employed. It was thought that in those cases where the differential diagnosis included a teratoma, a negative hormone report would not be conclusive and a positive hormone report would be dependent upon the complete exclusion of any other source of the hormone.

I. Artificial Pneumothorax. Advances in chest surgery have made this procedure unnecessary as a preliminary phase of preparation for surgical exploration of the thorax. It does not appear to have value except in those few cases where it is not possible to determine whether a mass is within the lung or adjacent to it in the pleural space or mediastinum.

J. Aspiration Biopsy. The value of this method of procuring material for histopathologic study is no longer questionable. The technique employed is essentially that outlined by Martin and Ellis¹ in 1934. In any group employing this method, the success depends upon the degree of cooperation of the surgeon, the radiologist and the pathologist, rather than upon differences in technique. In our group the aspiration is carried out under biplane roentgenoscopic guidance in order to be certain of the exact site of the needle during the aspiration maneuver.

In solid tumors of the types reported here, a negative report has little significance unless repeated on three or four occasions, and then due consideration must be given to the possibility that we are dealing with a non-neoplastic process. It is our opinion that teratomas, cysts, carcinomas, sarcomas, aneurysms, and the lym-

¹ Martin, H. E., and Ellis, E. B. Aspiration biopsy. *Surg., Gynec. & Obst.*, 1934, 59, 578-589.

phoblastomas can be confirmed or ruled out with a high degree of accuracy by needle aspiration biopsies.

We have no hesitancy in inserting a needle of small caliber into a mass so situated that an aneurysm must be considered a diagnostic possibility. In these cases a very thin needle is used. There have been no complications and no diagnostic

astinum and which were oval or spherical in outline (Fig. 1). (2) Primary spherical parenchymal tumors. In most instances it was not possible to determine roentgenographically whether the mass originated in the mediastinum or adjacent to it. The primary spherical parenchymal tumors were identical with blood borne metastatic lesions. The fact that only one tumor was

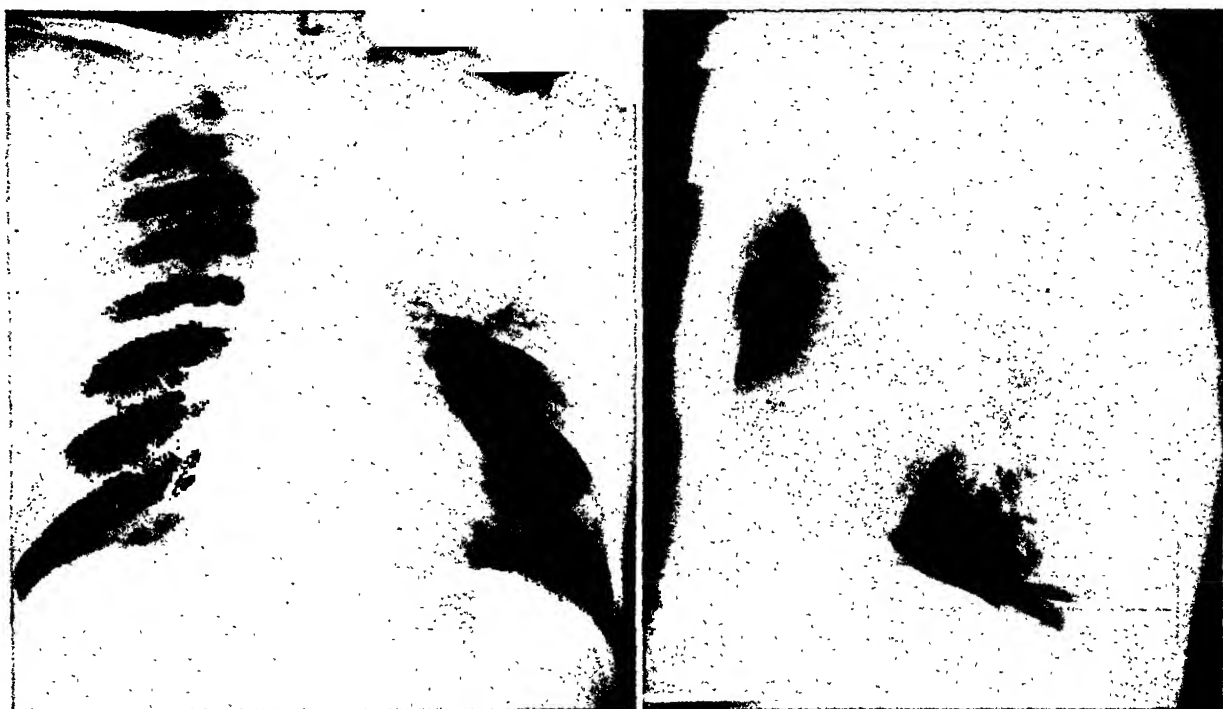


FIG. 1. Bronchiogenic carcinoma. This paramediastinal mass resembled a cyst. It was within the lung and did not involve the parietal pleura. Aerated lung surrounds the mass on its ventral, lateral and dorsal borders (Table I, Case 1).

errors as determined by subsequent exploration or autopsy.

Teratomas have been aspirated without infecting the pleural space or the development of any other complication.

On a number of occasions we have attempted to pass a needle into small, spherical masses of the type commonly referred to as tuberculomas. In these instances we have been unsuccessful. Several times the mass was contacted but the needle would not penetrate it.

DISCUSSION OF CASES

A. Carcinoma of the Lung. These tumors were of two types: (1) Bronchial carcinomas originating adjacent to the medi-

astinum and that it was relatively large suggested that we might be dealing with a primary neoplasm.

B. Tumors of Nerve Tissue Origin. These tumors were of two types: (1) Neurofibroma or neurinoma which develop from the nerve sheaths and occur anywhere along the course of a nerve. They are usually benign but, at times, they undergo transformation and become invasive tumors such as sarcomas. They are usually oval in contour with the long axis along the longest diameter of the body. They may occur in any part of the chest where nerve tissue is found but most of them occur posteriorly along the dorsal spine. (2) Ganglioneuromas which develop in the

TABLE I
TABULATION OF CASES—CARCINOMA OF LUNG

Age and Sex	Clinical Features	Location of Mass	Size in cm.	Needle Biopsy	Treatment and Subsequent Course	Diagnosis and Remarks
Case 1 M—58 W.M.	Cough for 4 weeks	Left paramediastinum lung root to apex	10×12×14	Positive	Pneumonectomy. Un- eventful	Bronchiogenic carcinoma
Case 2 M—44 M.T.	Pain left upper chest, 4 months	Left paramediastinum lung root to apex	11	Positive	Exploratory. Inoperable. Retrogressive	Carcinoma. Slight response to complete course of deep roentgen therapy
Case 3 M—52 E.R.	Pain in right chest and arm. Weight loss, 7 weeks	Right paramediastinum lung root to apex	9	Positive	Inoperable. Horner's syndrome. Pain in arm. Unimproved	Undifferentiated carcinoma
Case 4 M—61 W.B.	Cough with hemoptysis, 3 weeks	Lung root to apex, right paramediastinum	9	Not done; tissue by bronchoscopy	Exploratory. Inoperable. Unimproved	Squamous cell carcinoma bronchus Grade 2
Case 5 M—56 C.F.	Cough, hoarseness, pain in left chest for 9 months	Left paramediastinum lung root to apex	11	Positive	Inoperable due to left recurrent laryngeal paralysis	Squamous cell carcinoma bronchus
Case 6 M—50 H.S.J.	Chest pain, cough with hemoptysis. Weight loss, 4 months	Right paramediastinum anteriorly lung root	8×6×6	Positive	Exploration. Inoperable due to mediastinum involvement. Progressively downhill. Death	Undifferentiated cell carcinoma grade 4, with invasion of mediastinum
Case 7 F—57 M.B.	Cough with hemoptysis, 2 months	Left paramediastinum lung root to apex	7	Positive	Pneumonectomy. Un- eventful	Squamous cell carcinoma, bronchiogenic
Case 8 M—52 V.A.	Hoarseness, headache and backache, 4 months	Right paramediastinum lung root to apex	10×9×7	Positive	Inoperable, left recurrent laryngeal palsy. Roentgen therapy. Unimproved under roentgen therapy	Carcinoma squamous cell type. Death in few months
Case 9 M—54 R.P.	No complaints in chest. Found in survey	Right paramediastinum posterior lung root to apex	7×6×5	Positive	Pneumonectomy. Un- eventful	Grade 4 undifferentiated cell carcinoma
Case 10 M—64 H.L.	Cough with hemoptysis. Hoarseness. Weight loss, 5 months	Right paramediastinum lung root to apex	8×8×6	Positive	Inoperable. Laryngeal nerve paralysis and fixed trachea	Grade 4 undifferentiated cell carcinoma
Case 11 M—48 E.L.	Cough with hemoptysis. Hoarseness and weight loss, 2 months	Left paramediastinum lung root to apex	12	Positive	Inoperable. Laryngeal nerve and phrenic paralysis. Fixed trachea	Carcinoma
Case 12 M—33 E.D.	Cough. Dyspnea on exertion. Hoarseness, 4 months	Left paramediastinum lung root to apex	6	Positive	Inoperable. Roentgen therapy. Left vocal cord paralysis. Death in 6 months	Carcinoma
Case 13 F—35 H.W.	Cough with hemoptysis, 3 months	Left upper lobe parenchyma	3×5×6	Not done; tissue by bronchoscopy	Bronchoscopic removal (partial). Seen recently. Treatment not yet completed	Adenoma bronchus
Case 14 F—35 M.McL	Survey film. No complaints	Right upper lobe parenchyma	4	Positive	Pneumonectomy. Un- eventful	Adenoma bronchus, low grade malignancy. The removed specimen and the material obtained on aspiration were identical
Case 15 M—45 J.G.	Cough, fatigue, fever, 5 months	Left upper lobe. Parenchymal lingula	6	Negative. Surgical biopsy	Pneumonectomy. Unimproved	Bronchiogenic carcinoma, squamous cell Grade 3. Died 1 year later cerebral metastases
Case 16 F—63 A.Y.	Survey film. No complaints	Left upper lobe, parenchyma	5	Negative. Surgical biopsy	Pneumonectomy. Un- eventful	Mucoid carcinoma. Needle biopsy repeated 3 times but insufficient material for diagnosis
Case 17 M—63 J.D.	Pain in chest. Dyspnea on exertion. Weight loss	Left base to anterior mediastinum	10×10×12	Positive	Had effusion partly covering mass. Had pleural involvement. Death in few months	Adenocarcinoma

cells of the peripheral nervous system, commonly in the sympathetic ganglia, may occur in any part of the thorax.

The symptoms of these tumors are chiefly due to local compression. Many are

discovered accidentally (Fig. 2).

C. Carcinoma of the Thyroid. The carcinoma probably arose in aberrant thyroid tissue. There was no evidence that the mass developed in an intrathoracic exten-

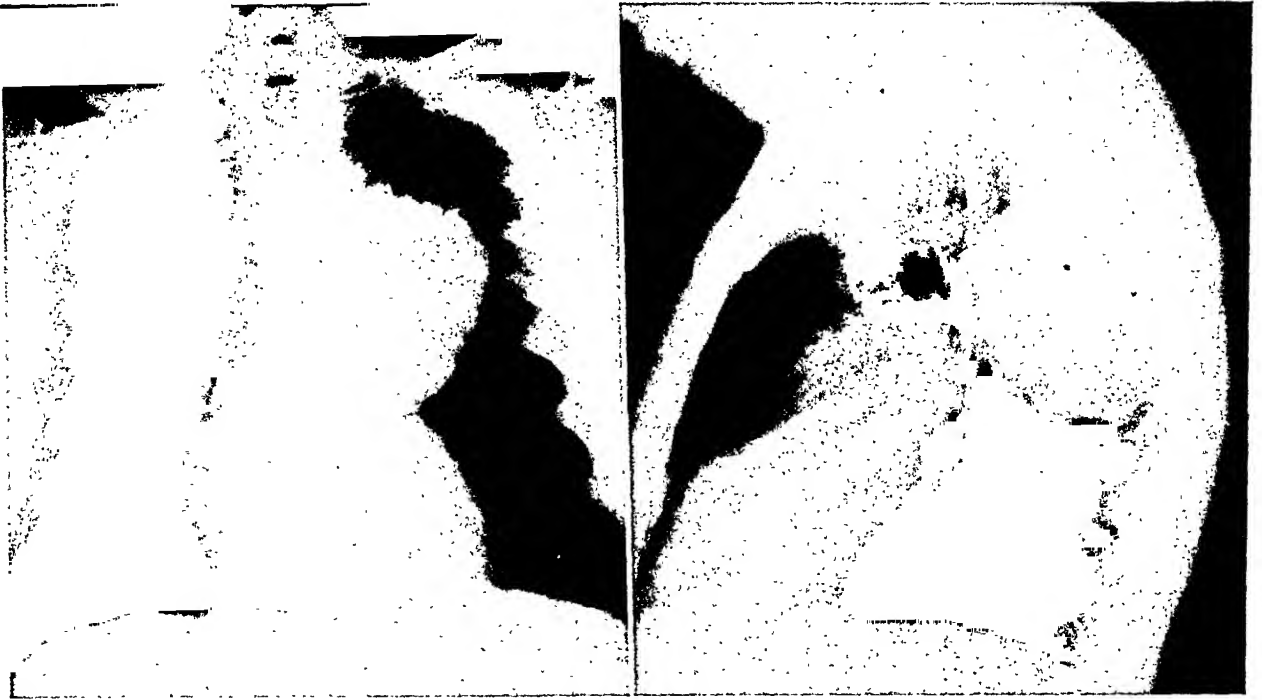


FIG. 2. Neurofibroma. This tumor is typical in appearance and location. The long axis of the tumor corresponds to the long axis of the body. It fills the gutter formed by the dorsal spine and the posterior rib cage (Table II, Case 1).

sign from the normal thyroid. The trachea had not been displaced in the usual manner of intrathoracic or substernal goiters. The appearance and location of the mass sug-

gested a tumor of nerve tissue origin (Fig. 3).

D. Bronchiogenic Cysts. These appear as solid tumors but are filled with fluid. They



FIG. 3. Carcinoma of thyroid. The contour and location of the mass resembles tumors of nerve tissue origin (Table IV, Case 1).

are of embryonic origin but do not have the characteristics of teratomas. The cyst wall has the histology of a bronchus. It consists of fibrous tissue which contains lymphoid follicles and mucous glands. The lining consists of a thin layer of pseudostratified cuboidal and cylindrical cells. There is no his-

normal. The trachea had been displaced to the left and it was compressed. The lateral view showed the oval outline of the mass extending anteriorly and posteriorly from the line of the trachea. A neoplasm was suspected in both instances as being more likely than an aneurysm. Aspiration of the mass

TABLE II
TABULATION OF CASES—TUMORS OF NERVE TISSUE ORIGIN

Age and Sex	Clinical Features	Location of Mass	Size in cm.	Needle Biopsy	Treatment and Subsequent Course	Diagnosis and Remark
Case 1 M—72 S.G.	Cough, dyspnea, weight loss, 6 months	Left posterior gutter lung root level	13×10×10	Positive	Unimproved	Neurofibroma. General condition of patient contraindicated surgery
Case 2 F—22 E.F.	Pain left chest, 20 months	Left lung root area	10×12×12	Not done. Surgical biopsy	Excision. Uneventful	Benign neurofibroma
Case 3 M—58 W.C.	Cough and pain in chest, 2 months	Left posterior mediastinum gutter lung root level	16	Positive	Roentgen therapy. Unimproved	Neurofibroma. Inoperable due to spine involvement. Sarcomatous degeneration. Death in few months
Case 4 M—44 R.C.	Unable to walk. Loss of bowel and bladder control, 30 years	Left posterior mediastinum gutter, lung root to apex	7.5×6×6	Not done. Surgical biopsy	Excision. No improvement	Neurofibroma. No improvement during 6 months follow up. Cord compressed by mass—"collar button" type
Case 5 M—45 W.B.	Pain and numbness in right shoulder. Difficulty in walking, 11 weeks	Right D-7, D-4 gutter	20×8×7	Not done. Surgical biopsy	Laminectomy. Excision. Death later	Neurofibroma. Collar button" type tumor. Confirmed at autopsy
Case 6 F—10 G.V.	Cough and fatigue, 4 years	Right posterior apex gutter	10×11×13	Not done. Surgical biopsy	Excision. Death	Ganglioneuroma
Case 7 F—28 M.K.	Pleurisy, intermittent attacks for 7 years	Right base, posterior mediastinum to gutter	8	Not done. Surgical biopsy	Excision. Uneventful	Neurofibroma. Had bloody effusion. Blood came from vessel in capsule as determined from removed specimen
Case 8 F—51 E.M.	Cough, dyspnea, pain in chest for 18 months	Right base, front to back	18	Negative	Excision. Uneventful	Neurofibroma
Case 9 M—41 C.M.	Pain in chest, 5 years	Left lung root anterior mediastinum	12×12×13	Not done. Surgical biopsy	Exploration. Retrogressive	Neurofibroma. Invaded mediastinum and lung. Specimen removed, histopathologically benign. Death in 3 years
Case 10 M—22 A.W.	No complaints. Detected in survey film	Left posterior mediastinum to gutter, lung root to apex	10×12×16	Negative	Excision. Uneventful	Ganglioneuroma
Case 11 M—60 C.H.	Cough, hemoptysis, dyspnea, pain and hoarseness for 2½ years	Right anterior mediastinum lung root to apex	15×18×20	Negative. Surgical biopsy	Exploratory. Unimproved. Roentgen therapy	Neurofibroma with sarcomatous degeneration. Inoperable due to invasion

topathologic evidence of any inflammatory response. The contents are clear fluid mixed with mucus. There are no contents similar to that found in teratomas. There were two cysts of this type—one adjacent to the anterior mediastinum and the other adjacent to the posterior mediastinum simulating an aneurysm of the descending aorta (Fig. 4).

E. Aneurysms of the Innominate Artery. In both patients the aneurysm appeared separated from the aorta, which appeared

by a small gauge needle established the diagnosis (Fig. 5). The second patient had a carcinoma of the stomach and the mass in his mediastinum was thought to be a metastatic process.

F. Aneurysms of the Aortic Arch. In most instances it is possible to differentiate between mediastinal tumors and aneurysms. The location of the mass in relation to the normal aorta is helpful but there are often exceptions. In 3 instances the diagnosis was



FIG. 4. Bronchiogenic cyst. This mass was superimposed on the aorta and could not be distinguished from it (Table IV, Case 7).

in doubt due to the unusual position of the mass particularly in its relation to the trachea and esophagus (Fig. 6).

G. *Teratomas*. There is nothing characteristic about these tumors. A few dermoids have teeth or osseous structures pres-

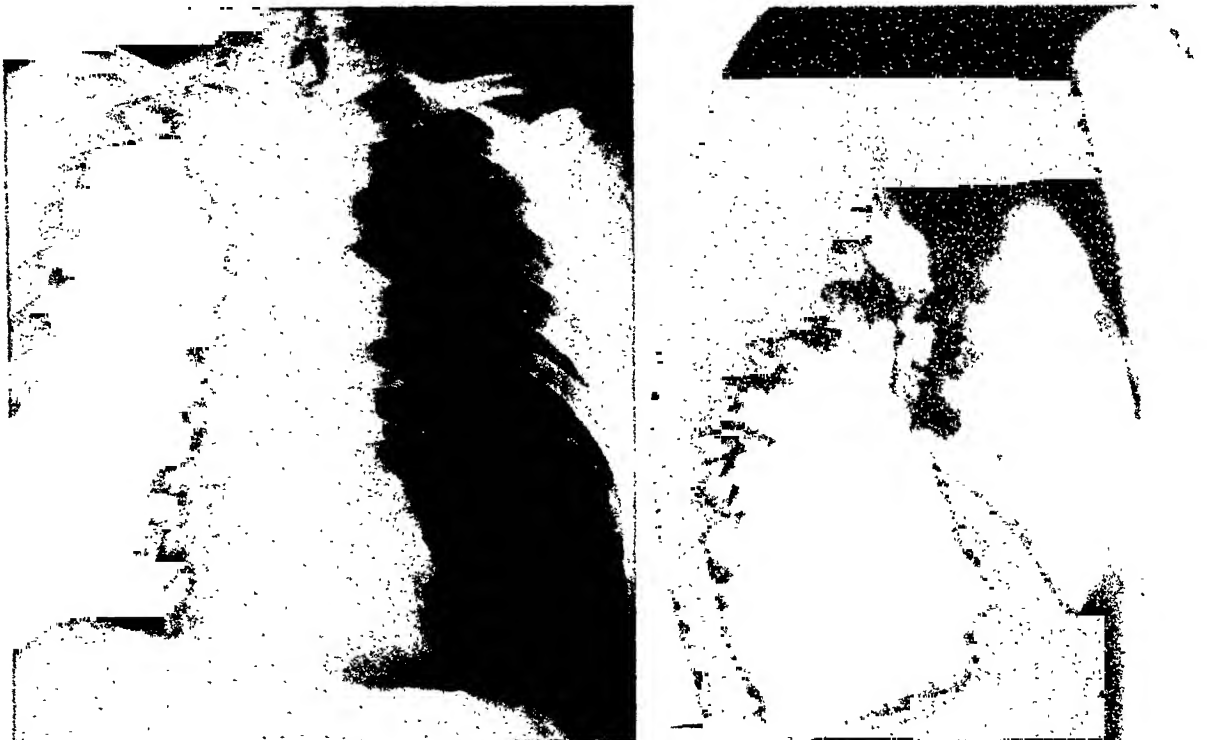


FIG. 5. Aneurysm of innominate artery. It was not possible to differentiate between an intrathoracic goiter, a paramediastinal bronchial carcinoma and an aneurysm. The marked compression of the trachea can be seen. Atelectasis of the anterior basal segment of the right lower lobe is also shown (Table III, Case 4).

TABLE III
TABULATION OF CASES—TUMORS WITHIN MEDIASTINUM

Age and Sex	Clinical Features	Location of Mass	Size in cm.	Needle Biopsy	Tissue (How obtained)	Treatment and Subsequent Course	Diagnosis and Remarks
Case 1 M—11 T.C.	Pain in back for 3 years	Behind heart mid-line at base	11×7×5	Positive	Lymph node biopsy later	Roentgen therapy. Death 4 years after onset	Hodgkin's disease. Mass appeared to be a dermoid or neurofibroma
Case 2 M—16 N.S.	Cough and fever for 3 weeks	Right lung root	12×8×6	Not done	Lymph node biopsy later	Roentgen therapy. Death 1 year after onset	Hodgkin's disease. Mass appeared to be vascular or a teratoma. Trial roentgen treatment made differential diagnosis
Case 3 F—28 H.D.	Cough and fever for 6 months	Right anterior paramediastinum	8	Not done	Autopsy	Roentgen therapy. Death 4 years after onset	Hodgkin's disease. Mass appeared to be a paramediastinal carcinoma. Marked response to trial dose roentgen therapy
Case 4 M—36 E.S.	Substernal pain and dyspnea for 2 months	Right paramediastinum	8×8×10	Positive		Antilutetic. Slightly improved	Aneurysm innominate artery, lues. Positive serology
Case 5 M—50 M.G.J.	Abdominal pain due gastric cancer	Right paramediastinum	10×8×6	Not done	Autopsy	Antilutetic. Death gastric cancer	Aneurysm innominate artery, lues. Positive serology
Case 6 M—52 H.B.	Brassy cough, dyspnea and hoarseness for 8 years	Right mediastinum	11	Not done	Autopsy	Splitting of sternum. Death due to asphyxiation. No rupture	Aneurysm of aortic arch which had extended behind trachea and esophagus and displaced them forward. Sac began 3 cm. from aortic ring
Case 7 M—70 C.G.	Cough and dyspnea for 4 months	Left anterior mediastinum	12×8×10	Not done	Autopsy	Antilutetic. Death due to rupture	Aneurysm of transverse aortic arch. Appeared on film identical with paramediastinal tumors. Had positive serology
Case 8 M—42 M.W.	Cough, dyspnea, and pain in chest for 18 months	Right mediastinum between trachea and esophagus	10	Not done	Autopsy	Antilutetic. Death due to rupture	Aneurysm of transverse and descending portion extending across midline between trachea and esophagus. Thought to be a cyst. Serology positive
Case 9 M—38 F.H.	None in chest	Right anterior mediastinum lung root	5×5×4	Positive		Roentgen therapy, very sensitive. Improved for 2 year follow up	Lymphosarcoma. Mass identical in appearance and location with the teratomas
Case 10 F—11 K.S.	Cough and wheezing for 6 years	Left mediastinum extending to base	10×12×15	Not done	Surgery	Excision. Uneventful	Thymoma. Easily removed
Case 11 M—58 J.McC.	Dyspnea	Left anterior mediastinum, lung root to apex	13×12×12	Positive	Surgery	Unimproved	Thymoma (malignant). Inoperable due to invasion
Case 12 M—53 E.F.	Pain in chest and fatigue for 18 months	Right anterior mediastinum ascending aorta level	9×5×3	Not done	Surgery	Excision. Death	Teratoma. Resembled aneurysm. Death resulted from bilateral pneumothorax and complications
Case 13 M—20 S.S.	Heart conscious. Pain in left shoulder for 3 weeks	Left anterior mediastinum lung root	10×8×7	Positive	Surgery	Excision. Uneventful	Teratoma, needle biopsy specimen adequate and representative

ent to give a clue but the solid tumors about the mediastinum are roentgenographically indistinguishable from any of several tumors of the type reported here. If the tumor is chiefly of ectodermal origin and if it communicates with a bronchus, hair or sebaceous material may be expectorated (Fig. 7).

H. *Thymoma*. There is nothing characteristic about these tumors, either as to location, contour, or effect on the adjacent structures. One of the tumors grossly resembled a lipoma. This mass was easily re-

moved and had only a few small blood vessels running into it.

I. *Mycelia of Fungus*. In this patient the mass resembled a parenchymal carcinoma. Repeated needle aspirations revealed a core of tissue made up of mycelia of the aspergillus. The possibility that this is a secondary invader rather than the primary etiologic factor is considered as being most likely. There were some changes in the pleura about the mass suggestive of an old tuberculous process but the tubercle bacillus could not be found. The patient has

TABLE IV
TABULATION OF CASES—MISCELLANEOUS

Age and Sex	Clinical Features	Location of Mass	Size in cm.	Needle Biopsy	Tissue (how obtained)	Treatment and Subsequent Course	Diagnosis and Remarks
Case 1 F—60 S.B.	Dyspnea, pain in shoulder	Right apex, posterior mediastinum	11×12×14	Positive		Tracheotomy. Death—48 hours	Carcinoma Grade 4, thyroid. Mass appeared to be a nerve sheath tumor or cyst
Case 2 F—11 J.M.	Cough for 8 years	Left lung root	10×8×5	Negative	Surgery	Pneumonectomy.	Fibroma. Mass had extended along lung root vessels. Tumor benign
Case 3 M—45 J.K.	Dyspnea, heart conscious and difficult swallowing	Left posterior gutter behind heart	15×15×10	Not done	Surgery	Partial excision. Improved	Fibrosarcoma. Invaded mediastinum and was inoperable. Much of mass was removed
Case 4 M—50 W.E.	Cough for 9 years	Right upper lobe in parenchyma	8	Positive	Bronchoscopy	Unimproved	Mycelia of fungus. Roentgen appearance was that of a neoplasm
Case 5 M—21 M.L.	None. Found on survey	Left anterior chest adjacent to ribs	11×9×5	Not done	Surgery	Excision. Uneventful	Rhabdomyosarcoma
Case 6 F—68 A.B.	Dyspnea, weakness, weight loss	Left thorax	25×23×20	Negative	Autopsy	None due to lack of time. Death within 48 hours	Rhabdomyosarcoma
Case 7 F—20 D.H.	Complaints none. Found on survey	Left posterior mediastinum level aortic arch	6×6×7	Not done	Surgery	Excision. Uneventful	Bronchiogenic cyst
Case 8 F—30 F.W.	Wheezing and dyspnea	Right anterior mediastinum lung root level	11×13×16	Positive		Aspiration. Relieved. Sac remained	Bronchiogenic cyst
Case 9 F—52 M.V.	None. Found on survey	Right base anteriorly	23×15×12	Negative	Surgery	Uneventful	Fibroma. Films made 9 years ago were reported negative but a review of them shows that a tumor 7×5×3 cm. was present in the right middle lobe region against the anterior chest wall

been followed several years and there has been no change, so there is little likelihood that we are dealing with an underlying neoplasm (Fig. 8).

J. *Adenoma of the Bronchus.* This inter-

TABLE V
RESULTS OF ASPIRATION BIOPSY

Diagnosis	Positive	Negative	Not Done
Carcinoma of the lung (all types)	13	2	2
Nerve tissue tumors	2	3	6
Carcinoma of the thyroid	1	0	0
Lymphosarcoma	1	0	0
Fibroma and fibrosarcoma	0	2	1
Bronchiogenic cysts	1	0	1
Aneurysms (all types)	1	0	4
Teratomas	1	0	1
Thymoma	1	0	1
Rhabdomyosarcoma	0	1	1
Mycelia of fungus	1	0	0
Hodgkin's disease	1	0	2
	23	8	19

esting tumor is usually detected after it has produced partial occlusion of a bronchus by its endobronchial component. We have been aware, for several years, that the bulk of the tumor is outside the bronchus in many cases. While some of these tumors are low grade carcinomas, others appear benign when detected and remain so. Of the two tumors of this type, one was spherical and was thought most likely to be a metastatic tumor (Fig. 9). There was no endobronchial growth on sections of the removed lung. The other patient's tumor appeared spherical and there was a mass projecting into the bronchus but it had not yet produced atelectasis.

K. *Hodgkin's Disease.* There were 3 patients who had tumors of this kind in whom Hodgkin's disease was not suspected at first. In 1 patient the spherical mass was situated adjacent to the mediastinum but it appeared to be within the lung and so resembled a bronchial carcinoma (Fig. 10). A second patient showed the tumor along the

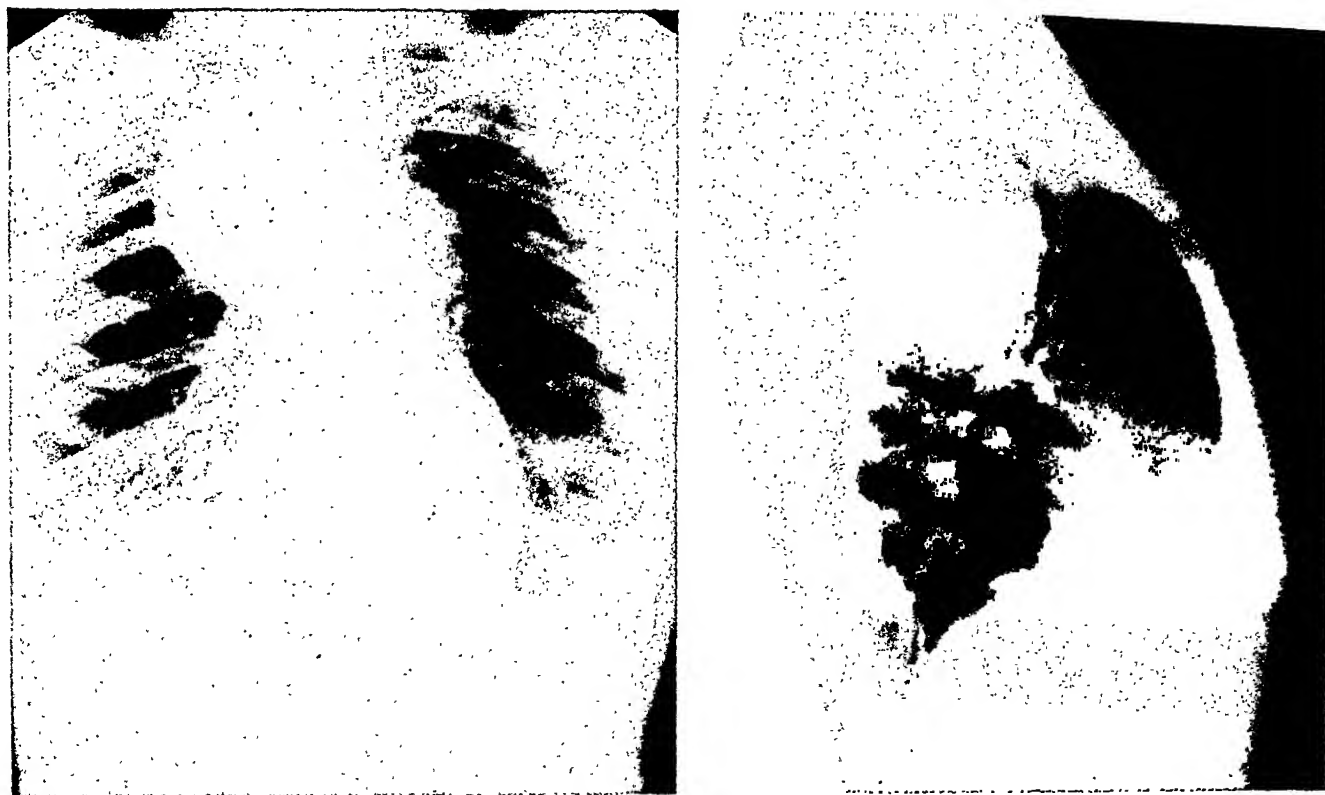


FIG. 6. Aneurysm of the aorta. The sac involves the transverse and first portion of the descending aortic arch. It extends to the right between the esophagus and trachea, pushing the trachea forward and compressing it (Table III, Case 8).

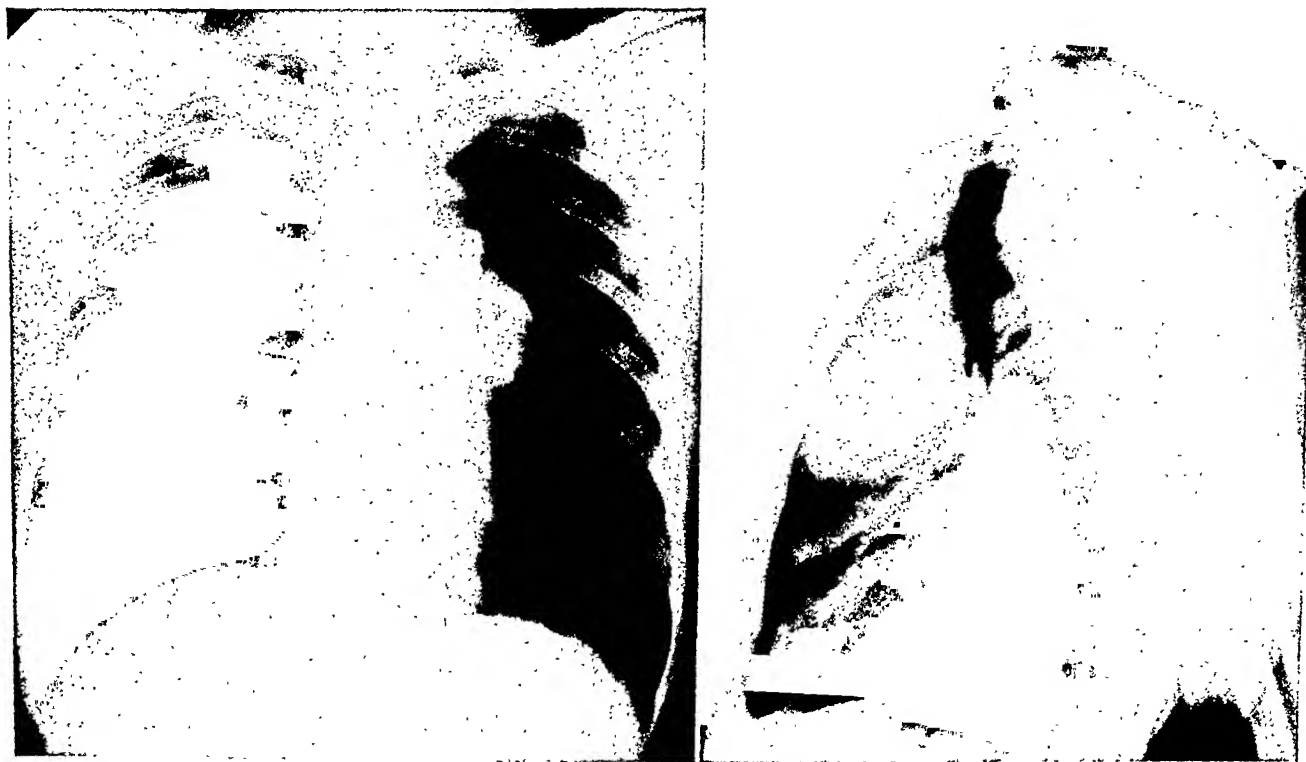


FIG. 7. Teratoma. This tumor was solid and made up of all three layers. There is no characteristic appearance of these tumors. Many errors are made if a presumptive diagnosis is arrived at by a study of the roentgenograms (Table III, Case 13).

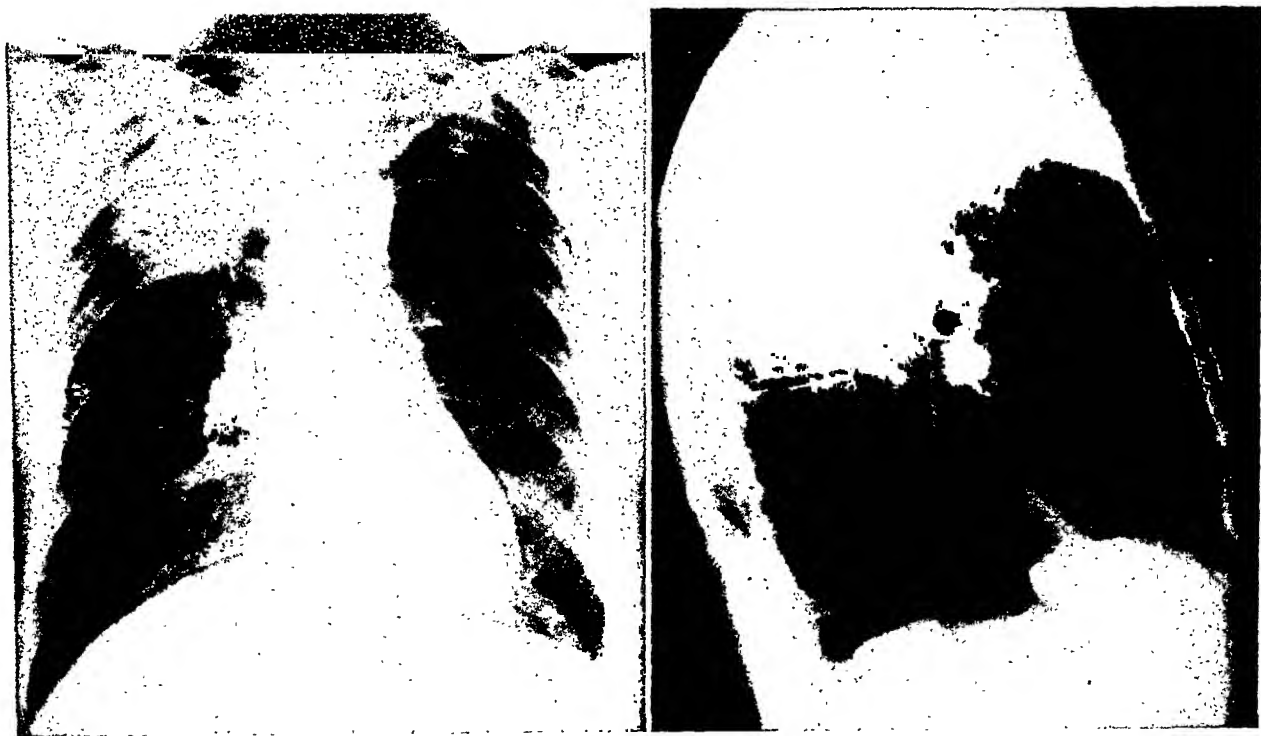


FIG. 8. Mycelia of fungus. This spherical mass was thought to be a bronchial carcinoma. The fungus was identified as aspergillus which was probably a secondary invader of an old tuberculous cavity (Table iv, Case 4).



FIG. 9. Adenoma of the bronchus. This spherical tumor had not produced symptoms. There was no reaction in the adjacent lung. The tumor grew during a short period of observation. Histopathologically the tumor was a low grade carcinoma (Table I, Case 14).



FIG. 10. Hodgkin's disease. This circumscribed paramediastinal mass presents a roentgen appearance nearly identical with a bronchial carcinoma and with an aneurysm which we have seen recently (Table III, Case 3).

ascending aorta and it appeared to be an aneurysm although a teratoma was also considered likely. In the third patient the tumor was behind the heart in the gutter against the dorsal spine and it appeared identical with the tumors of nerve tissue origin.

L. *The other tumors* of this group showed no gross characteristics that would in any way aid in their differentiation.

SUMMARY AND CONCLUSIONS

1. An increasing number of solitary tumors of the chest are coming to the attention of roentgenologists and thoracic surgeons as a result of mass surveys.

2. Competent roentgenologists are unable to make an accurate diagnosis by roentgenoscopy and a study of the films in many instances.

3. Fifty proved cases (those illustrated are representative) have been reviewed in order to determine the best means of arriving at an exact diagnosis. Most of these tumors are of three types: (a) bronchial carci-

nomas, (b) nerve tissue tumors, and (c) aneurysms.

4. Intelligent management of patients having solitary tumors of this kind (many of which were asymptomatic) depends upon the exact nature of the mass. It is a great advantage to be able to establish the diagnosis promptly so that therapeutic measures can be planned and carried out without delay.

5. Needle aspiration under roentgenoscopic guidance for the purpose of procuring material for histopathologic study afforded us the most prompt and accurate method of establishing the diagnosis (74 per cent of cases).

6. There are no roentgen findings that can be considered characteristic of any particular type of tumor. In many instances the diagnosis which was finally established was not considered among the possibilities when the first examination was made.

Samuel Merritt Hospital
Oakland, California

BRONCHIAL PERISTALSIS*

By FELIX G. FLEISCHNER, M.D.

BOSTON, MASSACHUSETTS

THE pulmonary parenchyma is in close relation to bronchi, vessels, septa, made up of connective tissue, and the pulmonary pleura. There is no portion of the pulmonary parenchyma of any considerable volume which does not contain bronchial branches. Thus any change in volume of any portion of parenchyma must cause simultaneous bending, twisting, lengthening or shortening of the contained bronchi. That these changes in the bronchi occur has been shown by means of bronchial casts made in expanded and collapsed lungs. The bronchoscopists were the first to see directly some of these changes in the living. Jackson reported that he was familiar with the rhythmical enlargement and diminution, elongation and shortening, twisting and bending of the normal bronchi observed through the bronchoscope. Due to the lesser respiratory changes in the central, hilar portion of the lung, and to the greater rigidity of the larger bronchi, these changes in length are minimal in the larger bronchial trunks during quiet respiration. The expansibility of the bronchi increases toward the periphery as the cartilaginous rings become thinner and are replaced by fewer and fewer cartilaginous plaques, while the muscular layers and elastic fibers grow thinner and scarcer. The elastic qualities of the respiratory bronchioles and alveolar ducts approach those of the lung parenchyma.

The classical anatomic description and the more recent studies by Baltisberger,¹ Macklin,^{9,10} Miller,¹² and others, demonstrated the large amount of elastic and muscular tissue in the entire bronchial tree. These morphologic facts by themselves suggest functional plasticity of the bronchi. This was later proved in more detail by roentgenologic observations. Macklin (1925) analyzed the lengthening and short-

ening, the spreading and approximation to each other of the bronchial branches in relation to the eccentric anchoring of the lung at the hilum and the uneven expansion of the different parts of the thoracic cage.†

Heinbecker⁴ (1927) observed the widening of the bronchi on inspiration, and their narrowing on expiration. This observation was confirmed by Hudson and Jarre⁶ (1929) Huizinga⁷ (1940), and others, and can be observed regularly during routine bronchography with roentgenograms taken in deep inspiration and expiration. These changes can be sufficiently explained by mechanical stress and strain exerted on the bronchial wall. There is little doubt that the lengthening of the bronchi is caused solely by the transmitted pull from the lung; the shortening is caused by the elastic recoil of the tissue, including the bronchial walls, since the bronchi do not carry any muscular fibers in longitudinal arrangement. The bronchial muscles are arranged in an approximately circular fashion, the "geodesic network" of Miller.¹² Therefore a synergic action of the bronchial muscles concomitant with mechanical widening and narrowing of the bronchi is a definite possibility.

Peristaltic movements of the bronchi were first described by Bullowa and Gottlieb^{2,3} in 1919. In a brief note they described roentgenoscopic observations made on dogs, the bronchi of which were made visible by an oily barium suspension; they saw "a slow peristaltic wave of low amplitude which emptied the lungs without cough and without invoking ciliary movement."

† Macklin's careful analysis of the uneven expansion of different portions of the lung is correct though it was made originally on a mistaken premise. He took the normal hilar shadows and lung markings for the expression of the bronchial tree and compared plain roentgenograms taken in inspiration and expiration without injecting any opaque matter into the bronchi. As a matter of fact, there is very close parallelism in the arrangement of vessels and bronchi, except for the central hilar regions.

* From the Department of Radiology, Beth Israel Hospital and Harvard Medical School.

Reinberg¹³ (1925), first experimenting with a bismuth suspension in the trachea of the goose, saw wavy contractions and bending of the trachea, and stated "and this bow is slowly drawing upward." He continued, "The contrast substance, being

—in short, the picture on the screen is animated, living. These movements proceed comparatively slowly, yet with such a speed that there is no reason to attribute them to the ciliary activity." Mayeda¹¹ interpreted his observations in a similar way.

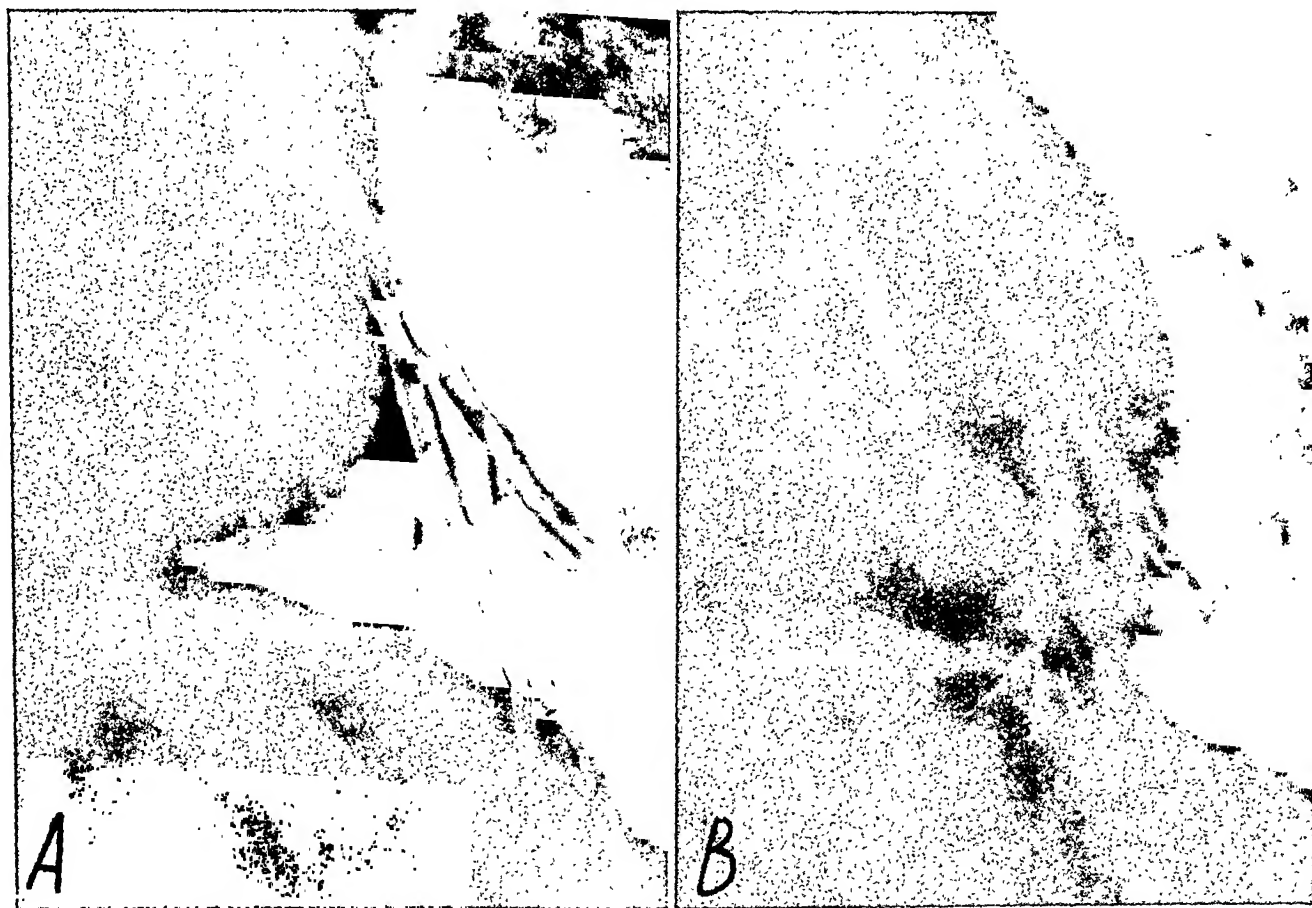


FIG. 1. Bronchograms. Reproductions in natural size showing a portion of the left lower lung field both in inspiration and expiration. *A*, inspiration; the bronchi are lined by a thin film of opaque oil (retouched). *B*, expiration; the same bronchi are readily identified. They are shorter and narrower. Plugs of oil form bridges from wall to wall. At their sites the lumen of the bronchi is narrower. The air-filled sections between oil plugs are patulous, but not contracted.

lifted by peristaltic action upwards. . . .” He also observed “the characteristic picture of peristalsis in man. A bronchus of the third or fourth order very soon after the injection of bismuth, represented as the shadow of a cylinder or column, becomes elongated, twisting, protruding upwards, further redressing itself, even flexing downward. Now the regular-shaped band-like shadow narrows, and has a divided fragmental appearance, falls into a few columns or spindles; the isolated shadows walk upward, collect themselves in nodules, leaving a clear interspace, disappear, again appear

PRESENT OBSERVATIONS

In bronchographic roentgenograms, the bronchi of the fourth and fifth order of the lower lobes present themselves in three ways, depending upon the degree of filling and phase of respiration. (1) The bronchus is completely filled with opaque oil; it appears as a band with parallel smooth contours. I have never seen in healthy persons any narrowing suggesting a localized contraction or multiple evenly spaced narrowings suggesting a moving contracting wave. (In asthmatics cylindrical and more rarely annular narrowings are quite common.)

(2) There is just enough oil to form a thin film coating the bronchial wall while the lumen of the bronchus contains air. Here, also, the bronchial walls are perfectly straight and not deformed by any irregularity suggesting localized contractions. (Again with the exception of instances of asthma or bronchitis.) (3) Some bronchi contain air and oil irregularly alternating with each other in shorter or longer columns or droplets. This picture observed under the screen often shows a slow centripetal movement of the oil droplets. This phenomenon apparently seen by the early observers was interpreted as proof of a peristaltic action of the bronchi. We have found pairs of roentgenograms taken on the same person in inspiration and expiration, respectively, as most illuminating (Fig. 1, *A, B*). If the inspiration film shows merely lining of the bronchial wall, the expiration film shows the corresponding bronchi filled alternating with oil and air. In expiration the bronchus is shorter and narrower as can be measured or even seen with the naked eye. The amount of oil present in the bronchus inspiratory dilatation, sufficient to coat the wall, is crowded together on a smaller surface in the collapsed bronchus during expiration so that the layer becomes thicker and the oil forms bridges and plugs extending from wall to wall. At the site of many of those bridging plugs the bronchus appears to be narrower than in the adjacent air-filled sections. By looking at those roentgenograms, one gets the impression that surface tension is the controlling factor in this phenomenon. One should keep in mind the fact that the air and oil make visible the lumen and inner relief of the bronchus; they do not provide any further information about the bronchial wall as such. There is no necessity to assume that those ring-like narrowings represent a dent or bend throughout the entire thickness of the wall of the bronchus. The mucous membrane is loosely attached to and readily movable upon the deeper layers of the bronchial wall. In postmortem specimens of over-

contracted lungs, one can often observe the mucous membrane of the bronchi arranged in transverse folds as a result of the heaping up effect which occurs when the bronchus shortens and narrows. Those roentgenograms suggest that the droplets of oil by means of their viscosity and surface tension elevate an abnormally large mucosal fold, thus making the bronchial lumen appear narrower. The slow centripetal motion of

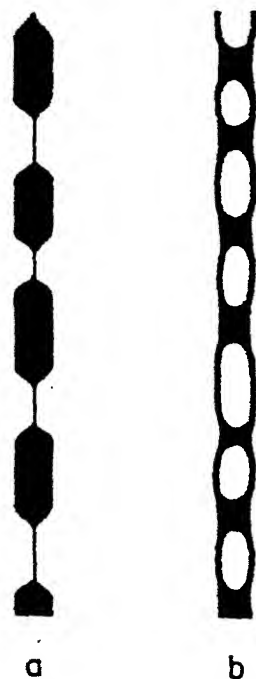


FIG. 2. (a) Diagram showing the manner in which the interrupted oil column was interpreted on the basis of roentgenoscopic observation solely. (b) The actual distribution of oil and behavior of the bronchus as revealed by roentgenograms.

these droplets, as observed roentgenoscopically, should be interpreted as caused by the action of the ciliated epithelium.

The early observers, working with the poorer technical means at their disposal, apparently interpreted this phenomenon as illustrated by the diagram (Fig. 2*a*). The continuous oil column is broken up by segmental contractions separating individual oil droplets or spindles. The slow progressive motion of the oil droplets was thought to be due to the squeezing effect of those slowly advancing rings of contraction; i.e., a perfect picture of peristaltic waves.

With modern roentgenographic tech-

nique, we never see contraction between those oil droplets in healthy individuals. The bronchus, if patent, is lined with a film of oil and otherwise air-filled. The bronchial wall itself cannot be discerned on roentgenoscopy (the means of observation of earlier authors) (Fig. 2*b*).

We interpret the narrowing at the site of the oil plug as an effect of surface tension of the oil, causing the lifting of mucosal folds. There is no way of disproving that these narrowings are due to the localized annular contractions of peristaltic waves. If this interpretation was correct, these contractions might, by narrowing the bronchial lumen and approximating the walls, cause the oil film to flow together, thus forming plugs. These waves of contraction, while moving, would carry the oil droplets along by means of surface tension. There is, however, another fact that strongly militates against the conclusion that this phenomenon is due to peristaltic contractions: we never see constricting rings in bronchi completely lined with oil and otherwise air-filled. In this case one may object, there is no need for the expelling action of peristalsis and the body does not mobilize this defense mechanism. However, we never see these narrowings either, if the bronchus is completely filled with oil, and here an expulsive defense operation would be very much in need. The narrowing rings have been observed solely where air and oil mix in the bronchus, only in instances where the effects of surface tension between air and oil in addition to that between oil and tissue becomes operative. We therefore conclude that this phenomenon is not peristaltic in origin.

Though we generally think of peristalsis as progressive contractions of the fibers of a circular muscle layer, there is no doubt that the longitudinal musculature of tubular viscera has its part in the performance of peristalsis. There is lengthening and shortening of segments of the tubular viscus concomitant with the passage of the annular contraction. All other hollow viscera

exhibiting peristaltic action have circular and longitudinal muscle systems. The smooth muscles of the bronchi are arranged solely in a somewhat modified circular fashion, the "geodesic system" of Miller. All students of the anatomy of the lung and bronchi agree in regard to the complete absence of longitudinal muscular systems.

This leads to the conclusion that the observed phenomena are probably due to surface tension and not to peristalsis of the bronchi. Since the theory of peristaltic activity of the bronchi was based solely on roentgenologic observations, according to our present knowledge, a further conclusion must be that nothing is known about bronchial peristalsis. The observations of earlier authors were correct; their interpretation was erroneous due to the incomplete facilities at their disposal twenty and more years ago.

SUMMARY

The assumption of peristaltic motility of the bronchi is based on the roentgenologic observation of the breaking up of opaque oil columns and slow centripetal motion of oil particles. These phenomena have been reviewed and interpreted as being due to surface tension and ciliary action. This observation does not permit any conclusion as to the occurrence of bronchial peristalsis.

Beth Israel Hospital
Boston, Mass.

REFERENCES

1. BALTISBERGER, W. Ueber die glatte Muskulatur der menschlichen Lunge. *Ztschr. f. Anat. u. Entwicklungsgesch.*, 1921, 61, 249.
2. BULLOWA, J. G., and GOTTLIEB, C. Roentgen ray studies of bronchial function. *Med. Rec.*, 1920, 97, 251.
3. BULLOWA, J. G., and GOTTLIEB, C. Additional experimental studies in bronchial function. *Laryngoscope*, 1922, 32, 284.
4. HEINBECKER, P. Method for the demonstration of calibre changes in the bronchi in normal respiration. *J. Clin. Investigation*, 1927, 4, 459-469.
5. HEINBECKER, P. Caliber changes in the bronchi in normal respiration. *Arch. Surg.*, 1929, 19, 1574-1576.

6. HUDSON, W. A., and JARRE, H. A. Cin-ex camera studies of the tracheo-bronchial tree. *Arch. Surg.*, 1929, 19, 1236-1244.
7. HUIZINGA, E. Ueber die Entstehung der Bronchiektasie. *Acta radiol.*, 1940, 21, 75-100.
8. JACKSON, C. Bronchoscopy and Esophagoscopy. Second edition. W. B. Saunders Co., Philadelphia, 1927.
9. MACKLIN, C. C. X-ray studies on bronchial movements. *Am. J. Anat.*, 1925, 35, 303-329.
10. MACKLIN, C. C. The dynamic bronchial tree. *Am. Rev. Tuberc.*, 1932, 25, 393-417.
11. MAYEDA, S. Röntgenologische Untersuchungen über die peristaltischen Bewegungen der menschlichen Bronchien. *Japan. J. M. Sc.*, III. Biophysics. Tr. and Abst., 1931, 2, 72.
12. MILLER, W. S. The Lung. Charles C Thomas, Springfield, Illinois, 1937.
13. REINBERG, S. A. Roentgen-ray studies on physiology and pathology of the tracheo-bronchial tree. *Brit. J. Radiol.*, 1925, 30, 451-455.



DOUBLE CONTRAST ROENTGENOGRAMS OF THE STOMACH

AN ADDITIONAL AID IN DIAGNOSIS

By EVERETT L. PIRKEY, M.D.,
Department of Radiology, University of Louisville
 LOUISVILLE, KENTUCKY

IN an effort to improve our accuracy in the diagnosis of lesions of the stomach we have been using an air-filled balloon in the barium-containing stomach.

This is not an entirely new procedure but these exact means have apparently never before been described in roentgenological literature. The first mention of such a procedure is in 1915 by Rogers and Hardt.¹ They used a balloon coated with a mixture of bismuth subnitrate and vaseline and covered by a second balloon for observing the physiological movements of the stomach. They made no mention of diagnostic possibilities.

In 1941 D'Eloia² described, in a preliminary report, a Miller-Abbott tube with two balloons, one of which was inserted into the first part of the duodenum and filled with water as an anchor, then rugar was given. The two illustrations presented were excellent. This method required placing the end of the tube in the duodenum, which is often a problem, then filling one

balloon with water and the other with air, all of which is quite time consuming.

Wasch and Epstein³ in 1944 reported the inflation of the stomach with air through a stomach tube after a contrast meal but used no balloon. They visualized tumors of the fundus but had little control over the positioning of the air or its retention.

Thomas⁴ in 1945 used air alone in the stomach to demonstrate large tumors and abscesses about the pancreas but he makes no reference to the diagnosis of intrinsic lesions of the stomach.

Poppel and Roach⁵ in 1945 describe the use of effervescent powders with an opaque meal. Tumors of the fundus were demon-

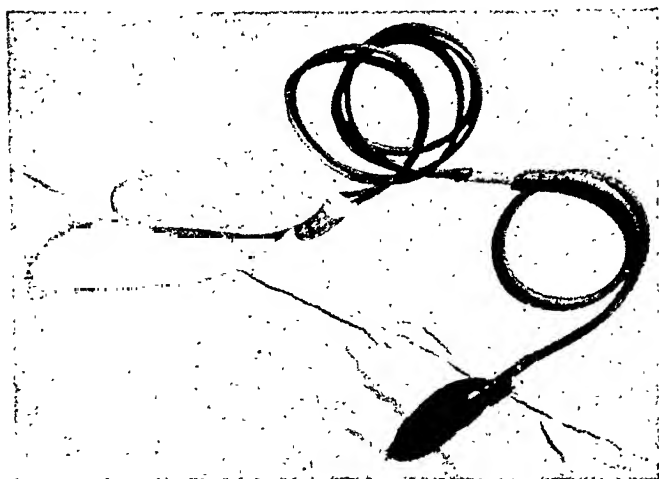


FIG. 1. Apparatus. Showing blood pressure bulb on end of tube with condom tied in place and partly inflated. It must be completely deflated during insertion.

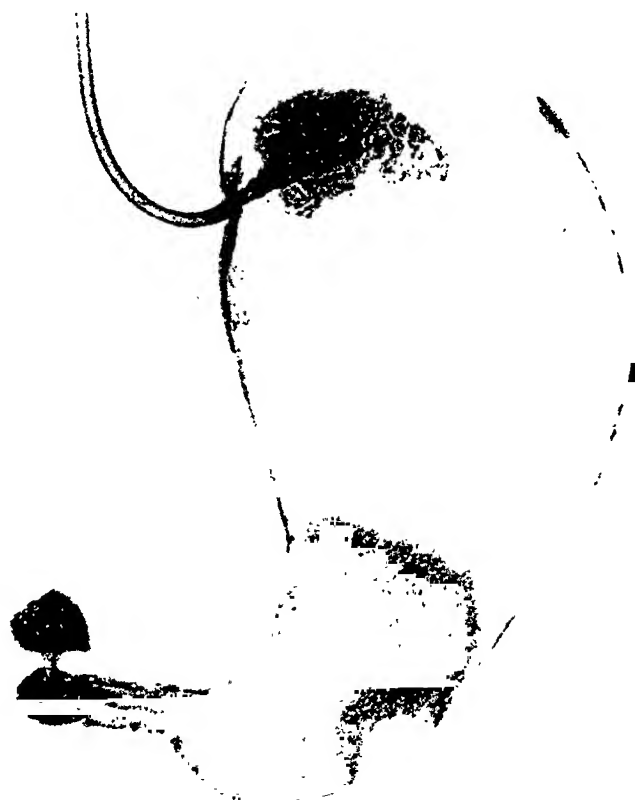


FIG. 2. Roentgenogram of postmortem normal stomach containing a small amount of barium sulfate mixture and markedly inflated balloon.



FIG. 3. *A*, usual anteroposterior roentgenogram of normal stomach. *B*, same stomach with inflated balloon. Note gastric outline under diaphragm.

strated very well by their method, but they have no control of the amount of distention.

The best previous discussion of a similar method was given by Gruber⁶ in 1945, but he used it primarily from the point of view of physiology. He did include one case of

tumor of the stomach, mentioning that the method may have possibilities in diagnosis.

METHOD

Our present method consists of the customary roentgenoscopic examination of the barium-filled stomach with the usual roentgenograms made. The patient then swallows a stomach tube (Rehfuss or Levine) with a latex condom tied tightly proximal to all the holes. A hand bulb from a blood pressure apparatus is attached to the outside end of the tube and under roentgenoscopic control the balloon is in-



FIG. 4. Roentgenogram of normal stomach with balloon taken in right anterior oblique position showing good double contrast effect.

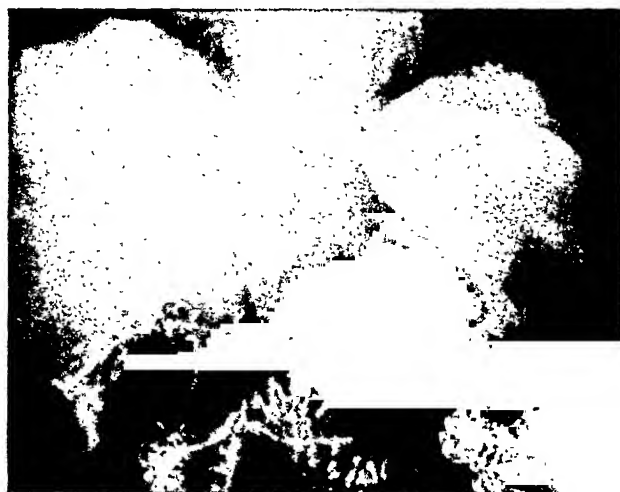


FIG. 5. Normal stomach in anteroposterior position with balloon in the prepyloric area and first part of the duodenum.

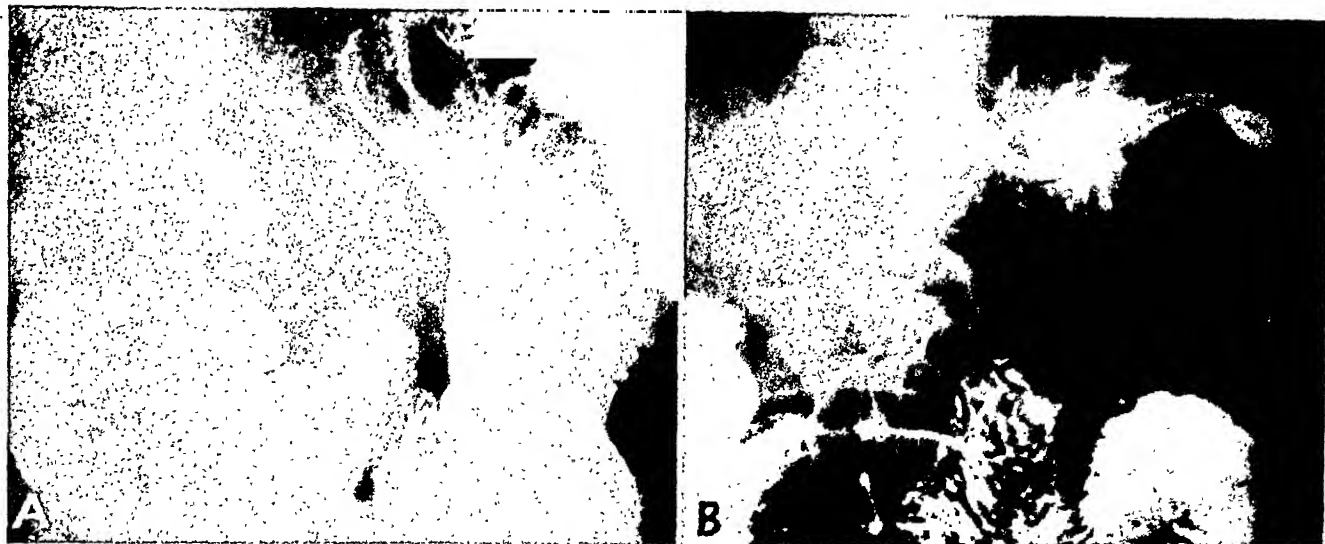


FIG. 6. *A*, usual right anterior oblique position for stomach. Note marked irregularity of mucosal folds of fundus along greater curvature. *B*; double contrast film of same case in same position showing smooth mucosal folds and small hiatus hernia. Gastroscopic examination showed normal stomach.

flated to any desired amount. This, of course, causes a varying degree of gastric dilatation and in most subjects it is possible to palpate the lower end of the balloon in the pyloric antrum, thereby giving transmitted pulsations to the fundus. Tilt-

ing of the patient will give control of the amount of barium in the fundus or prepylorus. The maximum pressure used has never exceeded 20 mm. of mercury as measured with a large dial sphygmomanometer.

None of the patients have complained of pain in spite of rather marked distention of the stomach at times. One patient attempted to vomit after inflation of the balloon but nothing happened. Two balloons ruptured while in the stomach but the patient was not aware of what had occurred.

We have been taking spot roentgenograms from time to time but our principal films have been made in the next room. The balloon is left in situ while the patient walks to the roentgenographic machine. Two roentgenograms are taken in the right anterior oblique position which allows the balloon to float into the fundus area and the barium sulfate to descend into the prepylorus. The other two roentgenograms are taken in the left posterior oblique position which gives the opposite effect in that the balloon floats into the prepylorus and the barium enters the fundus. It is best to reduce the peak kilovolts used about eight for films when the balloon is inflated. The roentgenograms are all taken with the patient horizontal.



FIG. 7. Normal stomach showing practically maximum distention. The patient had no complaints referable to the balloon. The intragastric pressure was 20 mm. of mercury.

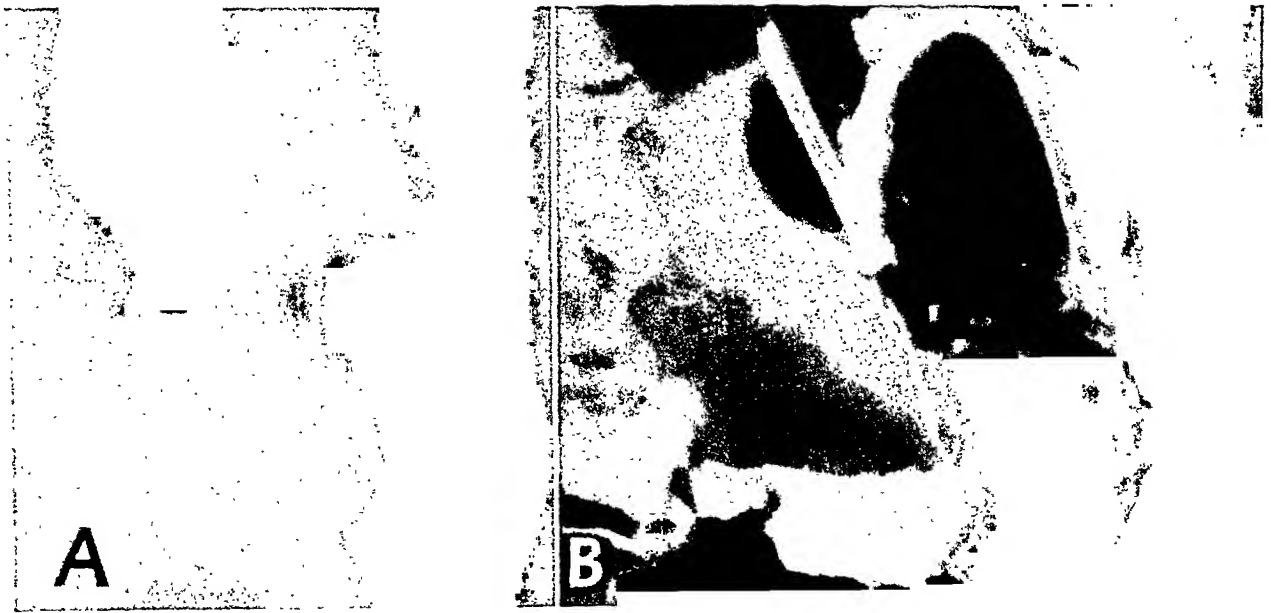


FIG. 8. *A*, spot roentgenogram of stomach showing apparent filling defect that was constant during roentgenoscopy. *B*, same case with double contrast technique showing defect erased by balloon. Patient was later gastroscoped and no pathologic condition found.

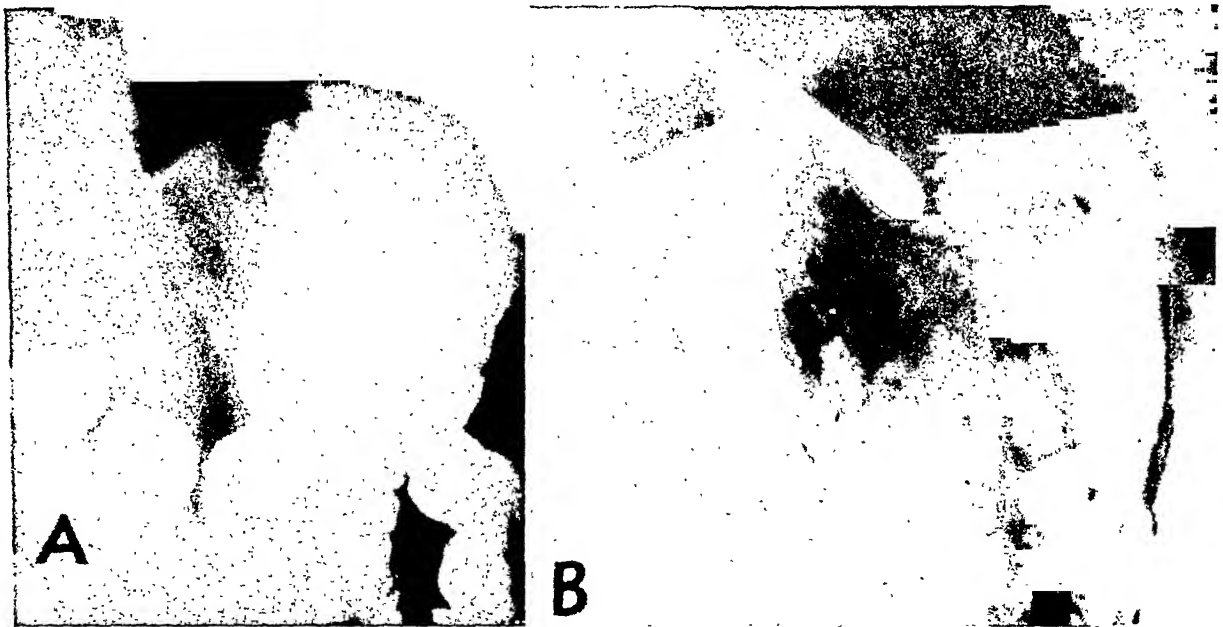


FIG. 9. *A*, usual right anterior oblique film of stomach showing polypoid-like lesion at esophageal opening. *B*, same case with double contrast technique and right anterior oblique position. Film is slightly blurred due to heart motion. There is normal outline seen about the cardia. Patient was explored nevertheless and no pathologic condition found when stomach was opened.

RESULTS

In our experience this method has been a very excellent means of obtaining what amounts to internal palpation of the stomach plus excellent double contrast roentgenograms of almost any area of the

stomach. It has been of value in reducing the number of false positive diagnoses, particularly in the fundus where external palpation is not possible. The cases shown in the accompanying illustrations are self-explanatory.

SUMMARY

1. A means of obtaining double contrast roentgenograms of the stomach is presented.

2. This method has been found to be of value particularly in reducing the number of false positive diagnoses.

3. It affords a means of palpation of the fundus of the stomach.

4. The authors feel that this method should be brought to the attention of roentgenologists, not as a panacea for all diagnostic errors but as an additional method in selected puzzling cases.

323 East Chestnut St.
Louisville 2, Kentucky

REFERENCES

1. ROGERS, F. T., and HARDT, L. L. J. Contributions

to the physiology of the stomach. *Am. J. Physiol.*, 1915, 38, 274-284.

2. D'ELOIA, A. S. Pneumogastroscopy. *Am. J. Surg.*, 1941, 53, 280-283.

3. WASCH, M. G., and EPSTEIN, B. S. Roentgen visualization of tumors of the cardia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 564-571.

4. THOMAS, S. F. Value of gastric pneumography in roentgen diagnosis. *Radiology*, 1945, 45, 128-137.

5. POPPEL, M. H., and ROACH, J. F. Roentgen diagnosis of deformities of the cardiac end of the stomach. *U. S. Nav. M. Bull.*, 1945, 45, 1111-1118.

6. GRUBER, W. F. New x-ray method of studying the anatomy and motility of the stomach and duodenum; its diagnostic value. *Am. J. Digest. Dis.*, 1945, 12, 127-137.

7. KIRKLIN, B. R., and GILBERTSON, E. L. Roentgenograms of the thorax that suggest carcinoma of the stomach. *J.A.M.A.*, 1947, 134, 1228-1230.



THE RELATION OF THERAPEUTIC RADIOLOGY TO CLINICAL MEDICINE*

By ARTHUR U. DESJARDINS, M.D.

Section on Therapeutic Radiology, Mayo Clinic

ROCHESTER, MINNESOTA

GENERAL CONSIDERATION

SINCE the therapeutic radiologist is continually called upon to treat a great variety of lesions, benign, inflammatory and malignant, it is essential that he should have a wide knowledge of the biologic and clinical features of these lesions. The greater is this knowledge, and the more the treatment is based upon it, the more likely are the cases selected for treatment to be chosen wisely, and the more favorable are the results likely to be. No one, I think, would venture to question the importance of this fundamental consideration.

Moreover, the more familiar is the radiologist with the biologic, pathologic and clinical aspects of the conditions which he must treat, the more respect will he command from his colleagues in medicine, pathology, surgery or in other specialties. But a common misfortune is that some radiologists have allowed themselves to lose contact with clinical medicine to such an extent that they can no longer examine patients thoroughly and confidently. As a result, the diagnosis as made by other physicians is accepted without question, and some patients are treated for conditions which they do not have. Under these circumstances, unfavorable results should not surprise anyone.

For this the radiologist may or may not be to blame. When he has not kept abreast of advancing knowledge—and here a sharp distinction must be made between real knowledge and the host of new notions that constitute but a transient medical fashion—he is to blame; when he has allowed his skill in physical examination to deteriorate or when he has failed to develop skill in physical examination, whether this has been

because he has worshipped too much at the shrine of the laboratory or because of the common tendency to take things for granted, he is again to blame. For many years the increasing reliance on laboratory procedures has caused a large proportion of physicians, internists, surgeons and others to give less and less attention to physical examination, and radiologists have suffered as much as others from this tendency.

Excessive specialization also has played an increasingly important role in altering the physician's outlook about his work. Specialization has undeniable advantages, but it also has disadvantages which should be recognized more than they are. Without any doubt it tends to increase knowledge in certain directions, but the more one concentrates one's attention to a limited field or to a single phase of a subject, the more this tends to reduce one's mental horizon, and the more one tends to lose one's sense of perspective or fails to develop this sense. Moreover, too early specialization tends to prevent one from acquiring a sense of perspective. The well-known saying that a specialist learns more and more about less and less is entirely true, but the logical conclusion is that, in time, the specialist learns everything about nothing.

During recent years the rapid increase in scientific developments, the tremendous increase in the number of workers in the field of science, and especially the widespread use of publicity for propaganda purposes have resulted in an excessive glorification of science, which is extremely dangerous because it misleads, not only the general public, but some of those who are engaged in scientific pursuits, into be-

* Read at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

lieving that science can solve not only scientific problems but even political problems. That this is not an exaggeration may be seen by reading Hogben's book, "Dangerous Thoughts."¹ Some seasoned scientists realize this danger and are frankly worried about it. In 1947 Smyth² wrote:

In the past two years science and scientists in this country have achieved a prestige which they have never had before. They have been credited with technical marvels that contributed largely to winning the war, they have lobbied on political questions, they have of necessity talked politics and international affairs. Advertisements have hailed them as harbingers of a new and better—or at least more mechanized—world. More concretely, the federal government is subsidizing basic research in a way hitherto unparalleled. All this is very flattering, but it is also dangerous. The degree of Ph.D. in physics or chemistry or some other science does not automatically stamp a man as great or wise or even very bright. An advanced degree, however, should represent a certain capacity for objectivity; a capacity that I think we might well turn to an examination of ourselves and our science at a time when we may be in danger of arrogance and conceit.

The foregoing factors affect everyone more or less, and physicians, including radiologists, are also affected. The glamour of science and of laboratory procedures in general has a tremendous influence on medical diagnosis, and to a considerable degree on treatment also. The great value of methods of precision cannot be doubted, but when these are applied to biologic material which varies within wide limits, or when they are employed by persons whose skill and experience vary a great deal, the value of the methods diminishes considerably. At the present time, it is fair to say that the majority of physicians rely far too much on the results of laboratory procedures; in fact, many of them base their diagnosis of a patient's illness on the results of this or that laboratory test, and when the tests are not conclusive, they are disappointed and sometimes they berate the clinical pathologists. The inevitable effect of this increasing tendency is that

skill in physical examination and the ability to analyze the history of the patient's illness and to correlate it with the physical findings have steadily diminished.

What effect has this had on radiology? As far as diagnosis is concerned, many internists, surgeons and others depend too much on the opinion of the roentgenologist. This may gratify the vanity of the roentgenologist, but it is a dangerous thing because it may easily lead the roentgenologist to assume that he knows much more than he actually does. Because the diagnosis of malignant tumors of bone largely depends on the opinions of roentgenologists, and because many errors result from this excessive and unwarranted reliance, I have not hesitated to make the foregoing comments. Almost as much might be said in relation to tumors of the mediastinum.

For the reasons which I have ventured to mention, the therapeutic radiologist should carefully avoid taking things for granted and accepting without question a diagnosis based largely or wholly on laboratory data, especially when the diagnosis does not explain the patient's major symptoms. He should insist on analyzing the history himself, on examining the patient, and on drawing his own conclusions.

At the beginning I mentioned that the radiologist may or may not be to blame for his failure to acquire a high degree of skill in physical examination, or for his failure to become familiar with the biologic, pathologic and clinical aspects of the great variety of conditions which he may be required to treat, and with the biologic action of the rays. Sometimes he may be only partly responsible for this situation, and in some instances his responsibility is almost nil. The fact is that, in some medical institutions, the attitude of the management or dominance of the work by a short-sighted internist or surgeon may produce an environment in which the therapeutic radiologist may be passively or actively discouraged from doing the best grade of work of which he may be capable.

Usually, when these conditions prevail, the radiologist himself is at least partly to blame, but not always. There is no denying that, in some institutions, personal popularity is more important than knowledge, and this occult factor may be a potent cause of undesirable conditions that may prevent the highest grade of work.

BIOLOGIC CONSIDERATION

Of greatest importance to the therapeutic radiologist is knowledge of the natural sensitiveness of different varieties of normal cells and tissues to roentgen rays, to radium and to other radioactive agents. This knowledge may be acquired by a critical review and analysis of experiments on animals, by analyzing the earlier observations of others in relation to the results of animal experiments, and by personal observation of the action of the rays on patients under treatment for inflammatory or malignant processes. This knowledge is invaluable, not only because it enables one to understand the effects of irradiation, but also because it often enables one, from these effects and from the rate at which they occur, to recognize the character of the lesions. And this may make it possible to verify the diagnosis which has been made or sometimes to show that the diagnosis could not have been accurate. It is unfortunate that only a minority of radiologists have given enough attention to this phase of their specialty to be thoroughly familiar with it and to be able to draw sound conclusions.

The slow and rather characteristic response of tuberculous lesions, the rapid abatement of acute inflammation caused by pyogenic bacteria, and the hastening of suppuration when furuncles or carbuncles are treated with roentgen rays are familiar examples. The gradual improvement of many chronic inflammatory conditions, or of keloid formations, after repeated exposure to suitable doses of roentgen rays is equally illuminating. The rapid and pronounced regression of sensitive neoplasms such as Hodgkin's disease or lymphosar-

coma, Wilms' tumors in children, embryonal carcinoma of the testis, endothelial myeloma of bone, or xanthomatosis in children, provides a striking contrast to the much slower response of epithelial tumors, to the comparatively slight and transient regression of neoplasms such as chondrosarcoma or osteogenic sarcoma of bone, and to the complete absence of regression of resistant neoplasms, such as myxosarcomas and hypernephromas.

As the radiologist's knowledge and experience increase, his clinical value increases in proportion; in time his ability to relieve the sufferings of patients or to cure them of malignant conditions with which they may be afflicted commands the respect of his colleagues.

CLINICAL CONSIDERATION

In connection with inflammatory as well as malignant conditions the radiologist should be thoroughly familiar with the clinical and pathologic features of the lesions, and also with the experimental background bearing on the action of the rays. Otherwise, it would be impossible to understand how the lesions are influenced by exposure to the rays. It must be admitted that, in relation to certain morbid conditions, the experimental data as well as the clinical reports do not furnish an absolutely convincing explanation, but often the evidence provides a reasonable or plausible explanation that can be used as a basis for further investigation.

In relation to malignant conditions many physicians know much too little about the natural history of different kinds of tumors; and for a therapeutic radiologist the lack of this knowledge is a serious handicap because, without it, a high grade of work is impossible. Needless to say, the radiologist should know the mode and rate of growth of each kind of neoplasm, the regions or organs most likely to be affected primarily and secondarily, the tendency of each kind of tumor to metastasize, whether metastasis is likely to occur early, late or not at all, and the regions or organs

most likely to become secondarily involved. Knowledge of this kind may be acquired from books, but it should always be carefully correlated with personal observation in as many cases as possible. When a radiologist accepts without question what earlier authors have written, he may be neglecting an excellent opportunity to contribute to the sum total of available knowledge, and he may unconsciously accept information which may be grossly misleading. Too often the writings of others are read without critical analysis, and the ideas and opinions of others are accepted at face value. This is a tacit admission that the reader himself does not know much about the subject and that he does not consider himself competent to judge between contending ideas or doctrines.

PATHOLOGIC CONSIDERATION

As far as verifying or identifying the character of inflammatory or neoplastic conditions is concerned, no one can deny the great value of microscopic examination of sections of tissue by an experienced pathologist. At the present time biopsy has become an invaluable procedure on which most physicians rely. In fact, the question is whether or not physicians rely too much on this procedure and on the opinions of pathologists. While pursuing their studies in school and hospital, most physicians have been so thoroughly indoctrinated concerning the value of biopsy that, throughout the rest of their lives, whenever they receive the opinion of a pathologist on the identity of a tumor, they disregard the history of the patient's illness, its clinical features, and the physical, roentgenologic and other findings; they stop thinking, and they accept the pathologist's opinion without further ado; and this regardless of the fact that sometimes the pathologist's opinion cannot be reconciled with the patient's history, with the clinical features of his illness or with the physical or other findings. What does this mean? It means that the majority of physicians do not know much more about

tumors than the meaning of the names by which different kinds of tumors are designated. So great has this trust in pathologists become that, at almost every medical meeting, one or more physicians who read papers have arranged their cases into two groups: "proved" and "unproved" cases. In the group of proved cases are included all those in which tissue from a tumor had been removed and in which sections of the tissue had been examined by a pathologist whose opinion had been accepted forthwith. In the group of unproved cases are included those in which tissue for biopsy had not been removed and in which the opinion of a pathologist had not been sought.

This blind and general reliance on the opinions of pathologists may be gratifying to some of them, but those who realize the tremendous burden of responsibility which is thus placed upon them do not relish it; but what can they do? The fact is that, as far as the identification of tumors is concerned, no pathologist, however experienced he may be, can always be accurate. One of the most eminent pathologists of this generation did not claim an accuracy greater than 85 per cent. It must be evident that, if the ablest pathologists cannot accurately recognize the character of malignant neoplasms in more than 85 per cent of cases, the accuracy of pathologists of lesser caliber is even lower. Many pathologists do not venture to express an opinion on the identity of a tumor without considering the history of a patient's illness as well as its clinical features and the physical findings; but others take a sort of pride in basing their opinion entirely on morphologic cellular changes. The accuracy of the latter is probably even less than that of the former.

Pathologists vary in knowledge and in intelligence as much as other physicians. Those who are teachers often impress their personality on their pupils to such a degree that, throughout their career, these pupils are loath to accept the opinions of other pathologists. Those who work in large hos-

pitals or clinics have a similar influence on other members of the staff. So prevalent is this tendency that, when a patient has been subjected to biopsy at another institution, the physicians of the second hospital refuse to accept the opinion of the pathologist of the first hospital, and either sections are obtained and are re-examined by the pathologist of the second hospital, or the patient is subjected to a second removal of tissue for biopsy. In other words, the attitude of the physicians of each hospital or clinic largely depends on their confidence in the ability of their own pathologist; this attitude, therefore, rests largely on faith.

Different pathologists often cannot agree on the essential character of a neoplasm. Disagreements of this kind are much more common than most physicians realize. Some pathologists, who have made a special study of epithelial tumors, often find "epithelioma" or "carcinoma" when other pathologists think otherwise or when the history and the physical findings indicate some other kind of neoplastic process. Other pathologists, who have given special attention to some other variety of tumor, tend to find evidence of this tumor when others to whom the same sections may be submitted find something else. When the same sections are sent to six different pathologists, it is not rare to obtain two, three or more different opinions. It must be apparent, therefore, that different pathologists have different criteria.

There is no doubt that microscopic examination of sections of a tumor by an experienced pathologist is the best single method of identifying a neoplasm that is available at the present time. But from the foregoing considerations it is evident that blind reliance on the opinions of the pathologists is not altogether warranted. When the opinion of a pathologist cannot be reconciled with the history, with the clinical features of the disease, or with the physical or roentgenologic findings, it should be received with the utmost skepticism. Sometimes, also, the biologic re-

sponse (rate and degree of regression) of a tumor to roentgen irradiation can furnish an invaluable clue to its character, and sometimes the evidence thus obtained is even more important than microscopic inspection of sections by a pathologist. But the best method of all is a critical analysis of all these elements.

PHYSICS AND RADIOLOGY

If a well-qualified therapeutic radiologist from another country were to come to the United States in order to see what American radiologists are up to and how they conduct their work, what would be his impressions? Perhaps his strongest impression, as far as the treatment of malignant neoplasms is concerned, would be that the majority of American radiologists treat all varieties of tumors essentially by the same method; and this regardless of the relative sensitiveness or resistance of different kinds of neoplasms. By this I mean that the majority of malignant processes are treated with roentgen rays generated at 200, 400, 600, 1,000 or even 2,000 kilovolts, and that the treatment is given by some variation of the fractional method. The total surface and tumor dose may be given in ten, fifteen, twenty, thirty or forty days, or even longer, and this dose may be given through one, two, three, four or more fields. But much the same method is employed whether the malignant condition is exceptionally sensitive to irradiation, as in Hodgkin's disease or lymphosarcoma, whether the tumor is only moderately sensitive, as in epithelioma or carcinoma, or whether it has a high degree of resistance, as in hypernephroma, mixed tumor of the parotid gland or myxosarcoma. This rather general tendency is not confined to this country; many foreign radiologists have tended to follow the same course.

How and why has this general uniformity in method of treatment developed? Because of several factors, among which perhaps the most important have been: (1) the desire to "standardize" treatment as much as possible; (2) the increasing de-

mand for rays of greater penetration; (3) the fact that, other things being equal, rays of different wavelengths have the same effect on cells and tissues; (4) the natural desire to avoid undesirable effects in the skin, and (5) the desire to diminish radiation sickness as much as possible.

To me, at least, it would seem that standardization of treatment has gone too far. There is no doubt that the other factors mentioned are valid and desirable up to a certain point, but not to the point of sacrificing still more important fundamental biologic considerations. The reason why the foregoing factors have been so generally adopted is not difficult to understand. For a number of years, at the annual meetings of the radiologic societies, courses of instruction have been held, and these have been deservedly popular. Among these courses one of the most popular has been the course on radiation physics, usually given by an outstanding physicist.

Given a homogeneous substance in a mass of definite size, a physicist can readily furnish exact figures on its density, specific gravity, permeability to water, heat and so forth. But when the substance is not homogeneous or when the size of the mass is irregular, the physicist no longer can furnish exact figures. For him the problem becomes increasingly difficult when the substance whose properties are to be measured is a mass of living tissues and cells which vary greatly in their composition, physiology and metabolism. When a physicist undertakes to measure the penetration and absorption of roentgen rays of a given quality in a substance of uniform composition, such as water, gelatin, wood or steel of a given density, the problem is relatively simple. He can even measure with accuracy the penetration and absorption of rays of a given quality in living tissue, but these measurements, however accurate they may be, do not give any indication of the relative natural sensitiveness or resistance of the tissue; they cannot take into account the different composition of different parts of the tissue, its blood and

nerve supply, the great differences in metabolism of different kinds of cells under different conditions, or the biologic changes that occur after exposure to different substances or agents.

If this is true of normal cells and tissues, it is just as true of malignant tumors. To a physicist a neoplasm is a mass of tissue; to him the differences in the natural history of different kinds of tumors, their tendency to metastasize early or late, the tissues or organs which are prone to be affected primarily or secondarily, and their great difference in sensitiveness or resistance to roentgen rays or to radium, mean very little. But to a therapeutic radiologist these biologic considerations should be at least as important as the penetration of the rays or as the number of roentgens that can be delivered to a certain depth in a certain number of days.

To illustrate what I mean, perhaps I may be allowed to use a pertinent example. The fractional method of irradiation or, as it is often called, the Coutard method, was based on the results of animal experiments; these had shown that, when a small dose of roentgen rays is given to a certain area every day, this can be continued until a very large total dose has been attained. When the total dose is sufficient, and when it is given within a certain number of days, it produces in the irradiated skin or mucous membrane a reaction the degree of which varies with the dose. When a small number of roentgens is given daily, or when the total dose is given over a large number of days, a much larger total dose can be given without permanent injury to the skin or other tissues. Other experiments having shown that, in order to arrest permanently the growth of a malignant epithelial tumor, from five to eight times an erythema dose is required, the fractional method of treatment is the only way in which a cancerocidal dose can be given without risk of serious and permanent injury.

From the foregoing considerations it is apparent that the fractional method of irradiation was designed to deal with

epithelial neoplasms or with other neoplasms that have an equal degree of sensitiveness to roentgen rays or that are even more resistant to the rays than epitheliomas or carcinomas. But instead of limiting the use of this method to epithelial and other resistant tumors, the majority of radiologists employ the same method to treat all malignant neoplasms, even the exceptionally sensitive tumors that arise in lymphoid structures, such as in Hodgkin's disease or lymphosarcoma. Some radiologists, it is true, do not give as large total doses as in the case of epithelial neoplasms, but others treat all tumors by the same method and with approximately the same total dose.

For several reasons this is an unfortunate practice which can be accounted for only by unfamiliarity with many of the clinical aspects of the different forms of lymphoblastoma, by lack of experience with a sufficient number of cases, and by the teachings of physicists who do not realize the great difference between epithelial and lymphoid tumors. Physicians in general have been taught, and they believe, that Hodgkin's disease or lymphosarcoma nearly always begins in the neck and spreads from the cervical nodes to the axillary and inguinal nodes. Most of the earlier writers believed this to be true, and some recent writers, such as Jackson and Parker,³ have stated that Hodgkin's disease nearly always begins in the neck. It is undoubtedly for this reason that, when therapeutic radiologists are called upon to treat a lesion of this kind, most of them limit their treatment to the neck, armpits and groins, although sometimes the mediastinum also may be treated.

The truth is that Hodgkin's disease begins in the cervical lymph nodes or in the nasopharynx or tonsil in about half the cases, or even less often. In an equal or even greater number of cases this condition begins in the retro-abdominal (para-aortic, mesenteric or iliac) lymph nodes. It begins in the mediastinal nodes only in a small proportion of cases; usually when these

nodes are affected, their involvement is secondary to earlier involvement of the cervical or retroperitoneal nodes. Only rarely does it begin in the axillary or inguinal nodes; nearly always, when the axillary nodes are affected, some of the mediastinal nodes were primarily or secondarily affected long before. And nearly always, when the inguinal nodes are involved, the retro-abdominal nodes have been involved for a long time. Lymphosarcoma may begin in any group of lymph nodes or in any lymphoid structure in the body, but once the malignant process has started, it tends to spread to other groups of lymph nodes in the same manner as Hodgkin's disease. This is also true of other forms of lymphoblastoma. Unfortunately, these important clinical features are not generally known, and this is one reason why many radiologists do not treat these diseases as well as they might be treated and why the results often are not as good as they might be.

But aside from these clinical considerations, the morbid process which, in these conditions, affects the lymph nodes and other lymphoid structures is so exceptionally sensitive to roentgen rays that the fractional method of irradiation, especially with rays generated at 200 or more kilovolts, does not yield as good results, immediately and for the long run, as another method which I have described in another paper.⁴ Instead of giving a small daily fractional dose for many successive days until a maximal total dose has been attained, each of the fields requiring treatment is given, in a single session on one day, a suberythema dose (550 r) or, if the patient cannot tolerate such a dose, each field receives half of this dose each day on two successive days. Naturally the number of fields requiring treatment varies in different patients at any given time according to the groups of nodes in different regions that are involved and that are responsible for the patient's symptoms.

Only a small number of patients who are afflicted with Hodgkin's disease or lympho-

sarcoma are first seen by a physician when only a few cervical nodes are involved and when lymph nodes in other parts of the body are not affected. Then it is sometimes possible, by thorough treatment, to bring about a complete and permanent cure. This can be done in one of two ways: (1) by giving to the affected region a course of fractional irradiation with a total dose of 2,000 to 3,000 r (rays generated at any voltage between 130 and 200 kv., or more), or (2) by giving to the involved area a dose of 550 r of rays generated at 130 or 140 kv., and by repeating this twice at intervals of three weeks.

In the great majority of cases, however, the malignant process, when the patients first consult a physician, has already invaded more than one group of lymph nodes, and sometimes the condition affects several groups of nodes, not to mention the spleen or the liver. Under these circumstances, any hope of a complete and permanent cure must be abandoned; but the patient's condition may be greatly improved by suitable treatment, and not infrequently this improvement can be maintained for many months or even many years. Radiologists who employ the fractional method with rays generated at 200 kv. or more may be gratified by the immediate effect of treatment on certain regions, but later, when the morbid condition again becomes active and when additional treatment is given in the same manner, the response is less favorable than it was the first time. After treatment by the fractional method has been repeated two or three times, it usually ceases to have any favorable effect, treatment with roentgen rays must be abandoned, and the patient no longer can look forward to even temporary improvement when the former symptoms recur or when fresh symptoms develop.

But this is not true when the fractional method has not been employed, when the fields requiring treatment have received a suberythema dose (in one or two days) of rays generated at 130 or 140 kv., when

treatment has been repeated once or twice at intervals of three or four weeks. When the treatment is arranged in this manner, it usually continues to have a favorable effect for many months or years, until the malignant condition reaches an advanced stage or until it enters the terminal phase.

I have used these two examples because they illustrate so strikingly the importance, for the therapeutic radiologist, of knowledge of the natural history of different kinds of tumors, of their clinical features, and also of avoiding too much standardization in treating them. Other examples could be described, but space forbids.

Mayo Clinic
Rochester, Minn.

REFERENCES

1. HOGBEN, LANCELOT. *Dangerous Thoughts*. W. W. Norton & Co., Inc., New York, 1940.
2. SMYTH, H. D. From x-rays to nuclear fission. *Am. Scientist.*, 1947, 35, 485-501.
3. JACKSON, HENRY, JR., and PARKER, FREDERIC, JR. *Hodgkin's Disease and Allied Disorders*. Oxford University Press, New York, 1947.
4. DESJARDINS, A. U. Salient factors in the treatment of Hodgkin's disease and lymphosarcoma with roentgen rays. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 707-722.

DISCUSSION

DR. JAMES T. CASE, Chicago, Ill. The remarks we have just heard constitute an able presentation of a most important theme which should never be lost sight of by radiologists, whether their interest is devoted more to therapy or to diagnosis.

A famous surgeon once remarked that he was a physician practicing surgery. We are physicians practicing radiology. Too often, some of our colleagues unintentionally (but thus revealing their innermost thought) refer to us as "x-ray men." This is largely the fault of those radiologists who neglect their opportunities to participate in the phase of medical practice which is usually referred to as clinical, as contrasted with the radiological aspect.

The dictionary definition of "clinical medicine" says that it is that part of medicine or surgery dealing with the investigation of disease in the living subject. It is certainly incorrect to build up a contrast between radiological and

clinical findings. The roentgen examination is a very important part of a clinical examination. Indeed, there are few maladies in which the roentgenologic study does not play some part in the clinical examination or in treatment.

We have had presented at this meeting numerous examples of the collaboration necessary in the study of the chest, for example. Certainly no persuasion is needed to accept the theme of

these remarks. Since radiology does enter so widely into the field of medicine and surgery in general as well as many of the specialties, it means that of all groups of physicians, the radiological group will be going to school for the rest of their lives in order to keep abreast of the advances in general medicine and the new developments in methods of examination apart from our own specialty.



PYELOGRAPHY BY RAPID INJECTION*

DESCRIPTION OF AN IMPROVED METHOD AND RESULTS IN 200 CASES

By LOUIS J. FRIEDMAN, HERBERT LOBSENZ and RUSSELL JAUERNIG

NEW YORK, NEW YORK

INTRAVENOUS pyelography, the method of forming a roentgenological shadow of the kidney and its appendages by the intravenous injection of a radiopaque compound which is eliminated in high concentration in the urine, is by now so firmly established as an informative and safe procedure that we shall offer no discussion of its merits. Present-day experience centers about two such compounds or media:

(1) 3,5-diiodo-4-pyridone-N-acetic acid, prepared in a solution of diethanolamine, furnished commercially as "diodrast";

(2) disodium N-methyl-3,5-diiodo-chelidamate, an aqueous solution furnished commercially as "neo-iopax."

Both media are accepted by the Council on Pharmacy and Chemistry; both produce excellent, workable views of the urinary tract following intravenous injection.

Neo-iopax, while perhaps not responsible for even a single death,^{2,4,5,11} has the disadvantage of occasionally producing acute pain in the injected arm during and for several minutes following administration.

The subject of the present report is a method of injecting neo-iopax that almost entirely eliminates the characteristic arm pain. It will show that rapid intravenous injection is the method of choice. Constitutional reactions to the injection were evaluated in an uncontrolled series of cases.

Instructions provided by the manufacturer of neo-iopax with each package state: "The contents are then injected slowly into the cubital vein." We disagree with this recommendation.

The same instructions are in error on the side of caution in a second respect: under "Contraindications" they state, "The use

of the drug is contraindicated in patients with severe liver disorders, nephritis or hyperthyroidism, and great care must be exercised in cases of uremia. Preliminary liver and kidney function tests are advisable in suspected cases. Caution must also be exercised in patients with any severe systematic disease." We have disregarded these contraindications.^{3,12} They were evidently suggested by the consultative staff of the manufacturer on the ground of any possible derangements in physiology which might be adversely affected and are not conclusions from actual untoward results. From our own experience these do not appear significant. We feel that this is important, since urographic information is often desirable in precisely the conditions named, and especially during established renal insufficiency the cause of which is still uncertain.

A third observation is that true sensitivity reactions¹³ did not appear in any case in our series. The recommended tests for sensitivity are (1) injection of a small amount, such as 1 or 2 cc., followed by a waiting period, and (2) the sublingual application of 1 cc. of solution, followed by examination of the mucosa in ten minutes for signs of edema, and after thirty minutes (the medium having been swallowed) general survey of the patient for allergic responses. We have simplified the test as follows: An injection of 0.1 cc. is made intravenously and the syringe left in situ. If no evidence of systemic reaction (by which we do not mean such incidental mild reactions as flushing or warmth) appears within thirty seconds the injection is completed. In all cases, regardless of the patient's weight, with the exception of small

* From the Roentgenological Service of the X-ray Division, Bellevue Hospital, New York.

children,⁶ we used 20 cc. of 50 per cent neopax.

The cases presented are 200 routine, successive, unselected patients undergoing urography in this department at the request of the various services under whose care they were. (Actually only 199 *different* patients are included, one having been examined twice during the series: entries 99 and 181.) Contraindications were disregarded, although it is evident from the diagnoses that the contraindications mentioned occurred frequently. The injection was made rapidly (in less than one minute) in practically all cases. To allow a free rapid venous return, the forearm was extended and the arm abducted to a position perpendicular to the body. The films thus produced demonstrated shadows at least equal to those obtained in our experience with this and other media in similar cases using the so-called standard routine.^{1,7,8,10,14,15,16}

Table 1 lists all our cases seriatim, with race, sex, age, diagnosis and reactions, if any. The usual entries are self explanatory, as to race (w white, c colored, y yellow), sex (m, f) and age. Since the diagnosis in many patients was not yet established at the time of the examination, as this was indeed the purpose of the urography, it often happened that our information was limited to the leading signs or symptoms; in that event we have indicated whatever information was available (using parentheses):

? Renal pathology (edema, albuminuria, casts, low spec. grav.)

(Pain in LUQ)

Burns, 3rd degree, of axilla (albuminuria; pyuria)

The customary abbreviations have been employed where convenient:

RUQ right upper quadrant (of the abdomen)

LLQ left lower quadrant

c.v.a. costovertebral angle

C.V.D. cardiovascular disease

C.N.S. central nervous system

Allusions to right and left have been

largely omitted from the table, except when material, as:

(Pain, right c.v.a. Nephrectomy 1924 reason unknown, left)

In describing the reactions attributable to the urographic medium, we have found it useful to abbreviate, using p for pain and b for burning, if slight in degree; *severe* pain or burning by P or B. Unless otherwise described, these reactions were limited to the injection site. In addition, we have designated infiltration by i, and erythema by e. General reactions have been abbreviated as follows:

- b burning (other than locally)
- d dyspnea
- e (emesis) vomiting
- f flushing (the site mentioned)
- h headache
- n nausea
- r retching
- s sweating (the site mentioned)
- v (vertigo) dizziness
- w sensation of warmth

In evaluating the distress caused by any injection, it is important to distinguish between expressions of "pain" and of "burning," and to discount such occurrences as "slight nausea" and "dizziness," since low grade complaints are common to nervous patients receiving an injection of anything whatever, even of sterile water; Case 160 is an interesting example of a purely emotional responses which might have passed for an important constitutional reaction, viz., a shaking chill, which could be stopped on command.

In the case of infiltration, a mishap that can never be wholly prevented and that is peculiarly troublesome when working with the small veins of children, some localized pain must be expected, whether the material be given rapidly or slowly; we do not, therefore, count these accidents as a feature of the technique under study. In one case (a child) the material was injected deep intramuscularly and no severe pain was noted. No absorption of medium was demonstrable over a period of three hours.

TABLE I

	Case	Sex	Age	Diagnosis	Local Reaction	General Reaction	Remarks
1	G.S.	w f	29	Pyelonephritis, acute bilat.	none	n 10 min. after inj.	
2	D.G.	w m	28	Paraplegia; cystitis	i, P	none	controlled by 1% novocaine dose 15 cc.
3	C.S.	f	4	? Renal pathology (recurrent frequency and fever)	none	none	
4	J.V.	f	25	? Renal tuberculosis	none	w during, n after inj.	
5	L.M.	f	40	? Renal tuberculosis	none	none	
6	F.H.	f	34	? Renal mass. Cirrhosis of liver	b during inj.	none	disappeared im-med. after inj.
7	F.L.	f	32	Pyelonephritis, chronic	b, p	none	
8	J.M.	f	31	(Frequency, urgency, RUQ pain)	none	none	
9	J.S.	m	64	(Urinary retention)	b	none	
10	V.D.P.	m	64	(Renal colic)	none	none	
11	J.M.	f	31	Pyelitis	none	none	
12	W.B.	m	71	. . . (deferred)	none	none	
13	M.D.P.	m	71	Renal lithiasis	none	none	
14	T.B.	m	66	Possible renal disease	i, b	s lower extremities	
15	C.V.	f	42	(Occasional back pain and suprapubic burning)	i, b	none	
16	E.L.	f	42	Essential hypertension	none	v	
17	C.A.	f	54	Pyelonephritis, chronic	none	w, f, v	
18	A.R.	m	72	Obstructive jaundice	none	none	
19	J.M.	m	59	. . .	none	w	
20	M.B.	f	54	(Pain in left flank)	none	v	
21	M.W.	f	54	(Back pain, frequency)	none	none	
22	A.D.	f	32	Renal calculi	none	none	
23	A.L.	f	57	Carcinoma of cervix; ? renal pathology	none	"cold mouth"	
24	H.M.	m	5	Hydronephrosis	ic b	none	dose 12 cc.
25	H.R.	m	37	Pelvic abscess; appendectomy	b	none	
26	M.S.	c f	54	Renal disease undetermined	none	none	
27	R.V.W.	m	43	(Cramping RUQ pain radiating to right c.v.a., acute onset)	none	none	
28	H.M.	m	5	Hydronephrosis	i, b	none	dose 12 cc.
29	L.P.	f	55	Paralysis agitans	b	none	
30	A.A.	f	66	Carcinoma of uterus	none	none	dose 5 cc.
31	M.B.	f	75	Hypertensive C.V.D. (decomp.)	b	n	
32	L.K.	f	43	Syphilis of C.N.S.	none	none	
33	A.McM.	f	30	(c.v.a. pain, chills, fever)	p shoulder	n transitory	
34	M.M.	f	28	? Renal calculus	none	none	
35	H.Z.	f	46	Carcinoma of cervix	none	none	
36	W.M.	f	53	Multiple sclerosis	p to shoulder	none	
37	L.C.	w f	57	Arteriosclerotic and hypertensive heart disease	none	none	
38	M.O.	c f	29	Pyelitis? Renal calculus?	p in shoulder	none	
39	E.M.	w f	65	. . . (deferred)	none	none	
40	N.McS.	w m	36	(Low back pain, 3 years)	p in shoulder	burning in mouth	
41	I.K.	w m	45	Fever of unknown origin	none	none	
42	E.McH.	w f	30	. . .	none	none	
43	C.C.	w f	1	Pyelitis, recurrent	none	none	20 cc. intramuscularly
44	L.S.	w f	38	(Lumbar pain, burning dysuria)	none	none	
45	A.W.	w m	65	Chronic nephritis	none	none	
46	A.M.	w m	57	(Pain L flank, increasing urinary frequency)	none	none	
47	C.S.	c f	68	Carcinoma of rectum (and vaginal bleeding)	b	none	
48	O.C.	c m	22	? Essential hypertension	none	n, v	unreliable?
49	A.L.	w f	34	Pulmonary tuberculosis	none	v	
50	D.G.	c f	56	Hypertensive C.V.D. and gastroenteritis	p shoulder	none	
51	H.C.	c f	24	Pulmonary tuberculosis	none	none	
52	J.R.	w m	56	Fistula in ano	none	n transitory	
53	J.T.	w m	75	Benign prostatic hypertrophy	none	none	
54	W.M.	w m	71	Benign prostatic hypertrophy with urinary retention	none	none	
55	E.L.	w m	17	Possible pyelonephritis	none	none	
56	Y.L.	w f	52	Hematuria, cause unknown	b	none	
57	P.K.	w m	62	Carcinoma of prostate	i, b	none	
58	M.S.	w m	65	Carcinoma of rectum	none	none	

TABLE I—(continued)

Case	Sex	Age	Diagnosis	Local Reaction	General Reaction	Remarks	
59	C.J.	c f	32	Pulmonary tuberculosis	none		
60	H.S.	c m	35	Pulmonary (? renal) tuberculosis	swelling	none	
61	L.V.	w f	31	Carcinoma of fundus of uterus	e	n	
62	H.M.	c m	37	? Pulmonary tuberculosis	none	e sudden	within 1 min.
63	H.S.	w m	66	Benign prostatic hypertrophy	p shoulder	v, n, thirst	
64	J.M.	w m	41	(Weakness; puffiness of face)	p shoulder	none	
65	R.L.	w f	53	(Back pain. Asthma 8 yr.)	none	none	
66	MB	w f	48	Hypertensive C.V.D. (blindness, headaches, weight loss)	none	none	
67	D.W.	w f	77	? Carcinoma, site unknown (Weight loss, anemia, ? mass in abdomen). Hypertension (hematuria)	none	none	
68	M.G.	c f	59	Nephrectomy 1940 (? traumatic)	none	none	
69	M.Y.	w m	57	Cirrhosis of liver (ascites, jaundice)	none	none	
70	A.McA.	w f	36	Cholecystectomy: postoperative. (Painless hematuria, 3 days)	none	none	
71	S.M.	w f	45	(Pain, right c.v.a. Nephrectomy 1924 reason unknown. L)	none	none	
72	J.W.	w f	48	(Slight hematuria)	none	none	
73	M.T.	w f	52	Carcinoma of cervix	none	none	
74	T.K.	w f	49	Hypertension. (Flank pain, radiating downward; frequency)	none	none	
75	B.F.	c m	69	Carcinoma of bladder	none	none	
76	E.Z.	PR m		Schistosomiasis of bladder (hematuria)	none	v	
77	P.O'B.	w m	13	? Glomerulonephritis ? Calculus	none	v, n	
78	TR	w f	33	Carcinoma of cervix	none	v, n	
79	R.D.	w f	46	(Hematuria)	none	none	
80	A.C.	w m	68	Glomerulonephritis, nephrotic	none	none	
81	E.M.	w f	57	Possible stricture of ureter	none	none	
82	R.S.	c f	28	Post-nephrectomy discharging sinus (Weight loss, ankle and facial edema)	none	none	
83	K.S.	w m	67	Ureterocutaneous fistula	"pins and needles"	none	
				Ureteritis cystica			
84	L.D.	w f	25	Cushing's syndrome	none	none	
85	V.L.	w f	40	Staghorn calculus	none	e after 1 min.	very nervous prior to inj.
86	B.T.	c f	19	Chorionepithelioma	none	none	
87	S.G.	w f	57	(Painful mass LLQ)	b	none	
88	M.B.	w m	77	Post-suprapubic prostatectomy	none	none	
89	JG	c f	27	Lymphadenopathy	none	none	
90	C.C.	w f	21	Pulmonary tuberculosis. Epilepsy. ? Renal tuberculosis	none	none	
91	H.W.	w m		Renal calculus	none	none	
92	S.W.	w m	46	Flank pain, severe, radiating to groin: Renal calculus to be ruled out	i, b	none	
93	I.S.	w m	57	Leukemia	none	none	
94	J.B.	c m	38	Pulmonary tuberculosis. ? Renal tbc	none	none	
95	T.T.	w f	54	Malignant hypertension	none	none	
96	P.S.	w m	42	Pulmonary tuberculosis. ? Renal tbc	none	none	
97	J.G.	w m	47	? Renal calculus	none	none	
98	MN	w f	52	(Mass RUQ = ? Kidney)	none	none	
99	E.K.	w f	58	Carcinoma of cervix	none	none	
100	H.P.	w m	57	Urethral stricture, old. (Pyuria)	none	none	
100	A.M.D.	c f	21	Gestation, intra-uterine	none	none	
102	B.W.	w f	62	(Pain in flank)	none	none	
103	A.McM.	w f	30	Stricture of ureter	none	none	
104	M.M.	w f	60	Papilloma of bladder	none	n	
105	M.A.	w f	7	Renal anomalies	none	none	dose 10 cc.
106	J.O.	w m	55	Typhoid carrier	none	none	
107	R.B.	w f	37	... (Pain in c.v.a.)	b	none	
108	J.M.	w f	44	Retrogastric mass	none	none	
109	V.A.	w f	59	Pyelitis	none	n, h	
110	E.B.	w f	40	Hypertension	none	none	
111	M.D.	w f		Tuberculous peritonitis	none	p 1 min. below L costal margin	
112	C.B.	w m	61	Uremia	none	none	
113	J.J.N.	w m	54	Abdominal neoplasm	none	none	
114	E.Z.	w m	57	Pneumoconiosis. Lung abscess	b	none	
115	J.J.	c m	54	... (Radiating mid-back pain)	none	none	
116	W.G.	c m	42	Hypertension	none	none	

TABLE I—(continued)

Case	Sex	Age	Diagnosis	Local Reaction	General Reaction	Remarks
117	L.N.	w f	42	Renal lithiasis	none	b mouth and pubic area
118	J.L.	w m	59	Renal calculus	p along arm above site of injection	f face none
119	T.F.	w m	45	? Renal calculus (lumbar pain)	none	"menthol" taste in mouth
120	J.M.	w m	61	Carcinoma of kidney	none	n, r, momentary d
121	B.T.	c f	30	Carcinoma of cervix	none	none
122	M.G.	w f	72	Hypertensive C.V.D. (enlarged heart)	none	h
123	G.K.	w m	20	Pyelonephritis	none	none
124	Y.C.A.	y m	28	Possible renal calculus	none	none
125	R.G.	w f	27	? Renal disease	none	v, n
126	D.S.	w m	68	Carcinoma, ? site (enlarged L cervical nodes)	none	none
127	F.T.	w f	64	(Abdominal mass)	none	none
128	J.F.	w m	44	Hypertension, severe	none	none
129	A.B.	w f	29	Transverse myelitis. Spastic paraplegia	p, b along arm	none relieved on flexion of elbow
130	P.B.	w m	44	Funiculitis	none	none
131	M.W.	w f	48	? Renal calculi (Pain in flank)	p mild aching	"chilly feeling" in abdomen unreliable person
132	J.C.	w m	50	...	none	n, r, b
133	D.B.	w m	64	? Renal calculus	none	none
134	J.S.	w m		Chronic nephritis. ? Polycystic disease	none	none
135	B.G.	w f	35	Ureteral stricture	none	none
136	M.W.	w f	80	(Pain in flank, persistent)	none	none
137	J.L.	w m	25	? Renal pathology (Back pain, pyuria)	none	none
138	P.O'B.	w m	13	? Bifid renal pelvis, bilateral (Hematuria, pain on urination)	none	none
139	G.A.	w m	53	Burns, 3rd degree, of axilla (Albuminuria; pyuria)	none	none
140	A.H.	c f	44	Post-nephrolithotomy for calculus	none	none
141	T.V.	w m		Hypertension	none	none
142	A.R.	w f	53	Hypertensive C.V.D.	none	none
143	N.E.	w f		Renal tuberculosis	i, p, e	p renal areas i 1 cc. after 12 cc. had been injected r, e before inj.
144	M.H.	w f	36	Hypertensive C.V.D. with uremia	none	none
145	E.K.	w f	58	Hypertensive C.V.D.	none	none
146	H.H.	w m	31	(Abdominal pain, fever)	none	none
147	L.D.	w m	39	Fractured pelvis. Ruptured bladder	none	none
148	C.S.	w f	43	Post-nephrotomy for calculi	none	none
149	S.B.	w m	64	Reticulum-cell sarcoma of spleen and lymph nodes	none	none
150	F.P.	w f	47	(Pain in LUQ)	none	none
151	G.V.L.	w m	68	Congestive failure, 6 mo. (Hematuria)	none	none
152	A.C.	w f	43	? Renal pathology (Edema, albuminuria, casts, low spec. grav.)	none	none
153	E.P.	w f	47	Carcinoma of cervix 1942. ? Radiation cystitis	none	none
154	I.C.	c f	58	? Pyelonephritis	none	w throat and perineum; v
155	R.K.	w m	38	(Mass in LUQ. Anemia)	none	none
156	J.Z.	w m	59	(Mass in LUQ)	none	none
157	M.W.	c f	34	Post-hysterectomy: ? ureteral obstruction	none	n; b in operated area
158	F.L.	w f	86	Pyelonephritis	none	none
159	T.B.	w m	40	Pulmonary tuberculosis	none	none
160	F.T.	w f	60	Ureteral calculus	none	shaking chill after 2 min. (emotional) chill stopped when ordered to remain quiet for film dose 10 cc.
161	V.M.	w f	4	Pyelonephritis	none	none
162	M.M.	w f	53	Hypertension	none	none
163	J.C.	w m	50	Probable conversion pain	none	none
164	S.K.	w m	18	Renal calculus	none	e
165	A.H.	w f	53	Carcinoma of cervix	none	none

TABLE I—(continued)

	Case	Sex	Age	Diagnosis	Local Reaction	General Reaction	Remarks
166	G.S.	w f	56	Carcinoma of cervix	none	none	
167	L.C.	w m	72	Pyelonephritis	none	none	
168	M.E.	w f	48	? Hydronephrosis	none	none	
169	L.H.	w f	28	Hypertensive C.V.D. Pyelonephritis	none	none	
170	H.B.	w m	75	Carcinoma of prostate. Metastases	none	none	
171	S.Y.P.	y m	88	? Renal neoplasm (Hematuria)	none	none	
172	M.S.	w m	82	Pyelonephritis	none	none	
173	K.C.	w f	46	Carcinoma of cervix	none	none	
174	N.S.	w f		... (Deferred)	none	none	
175	J.D.	w m	47	Renal calculus	none	none	
176	E.W.	w f	13	Osteomyelitis of tibia	none	n	dose 18 cc.
177	Y.Y.	y m	53	(Pain and rigidity LUQ)	none	none	
178	W.R.	w m	62	? Renal calculus	none	none	
179	F.B.	w f	63	(Pain in flank, 10 yr.)	none	none	
180	V.F.	w m	59	Cystitis	none	"numbness" in abdomen	
181	E.K.	w f	58	Carcinoma of cervix	none	none	same as Case 99
182	A.H.	c m	54	Hypertensive and arteriosclerotic heart disease	none	none	
183	J.K.	w m	37	? Polycystic kidneys	none	none	
184	S.S.	w m	72	? Carcinoma of kidney	none	none	
185	A.C.	c m		Rheumatic fever, acute. Rheumatic heart disease	none	none	given over a 3 min. period
186	W.K.	c m	52	Hypertensive cardiovascular disease. Nephrosclerosis	none	none	
187	N.C.	w m	73	Carcinoma of prostate	none	none	
188	D.J.	w f	53	Urolithiasis	none	none	
189	A.C.	w f	32	? Renal neoplasm (abdominal mass and pleural effusion)	none	none	
190	A.K.	w f	28	(Pain, suprapubic and in flank)	aching in shoulder and arm for 4 min.	n, r for 2 min., chills and general trembling for 4 min.	20 cc. given slowly in 2-3 cc. portions in 5 min. History of hay fever and e after diodrast
191	S.B.	w f	45	(Pain in flank, nocturia, frequency)	none	none	
192	L.D.	w f	27	? Ureteral calculus	none	n	
193	A.J.	w f	28	Carcinoma of cervix	none	none	
194	R.M.	w f	19	Congenital heart dis. Epilepsy (Nausea and vomiting)	none	n	
195	L.M.	w f	43	Pyelonephritis, acute	none	none	
196	S.K.	w m	64	Cholecystitis. Hypertension	none	none	
197	J.C.	w m	7	Congenital obstruction causing retention	none	none	dose 10 cc.
198	L.G.	w m	35	(Pain over both kidney areas)	none	n	
199	A.S.	w m	70	Chronic nephritis	none	none	
200	M.F.	w f	69	(Acute retention)	none	none	

Despite the lack of organic abreaction we strongly advise against intramuscular or subcutaneous injection of the medium.

Our interest in this series lay in the frequency with which clear-cut, definite arm pain is experienced by patients receiving the rapid injection. There were, in all, 10 patients who described distress other than slight localized burning, in the series of 200 cases, or approximately 5 per cent (Cases 36, 38, 40, 50, 63, 64, 118, 129, 131, 190). The pain was felt, in most of them, in the shoulder rather than in the arm, or at least

between the injection site and the shoulder. In our experience the pain was rarely severe, and special measures to combat it were not required. Contrasting these findings with the seemingly marked distress and the need for (or at least the use of) analgesics by mouth, heat applied locally, etc., when slow administration of the medium is used as reported by other workers, we have formed the conclusion that it is practical and wholly successful to administer neo-iopax as rapidly as possible. We go further and assert that by the use of this

technique it should be possible to limit all intravenous urography to this one apparently non-lethal medium and still dispense with the inconvenience of local pain which has been at times associated with it.

SUMMARY

The rapid intravenous administration of neo-iopax as a urographic medium in 200 cases is shown to eliminate all except an occasional, brief, initial, mild arm pain, and to make unnecessary the use of analgesic measures for such pain. The method recommended is to inject the solution through a 19 to 20 gauge needle in one minute or less, preferably within thirty seconds, with the arm extended and perpendicular to the trunk. No mortality or severe untoward reactions were encountered in this series.

We do not consider valid the usual list of "contraindications" to this medium as all of the numerous patients thus classified tolerated the administration of the medium without incident. No true contraindication existed in our series.

X-Ray Division
Bellevue Hospital
New York 16, N. Y.

REFERENCES

1. BRAASCH, W. F. Intravenous urography. *Surg., Gynec. & Obst.*, 1930, 51, 421.
2. CRANE, J. J. Sudden death following intravenous administration of diodrast for intravenous urography. *J. Urol.*, 1939, 42, 745-748.
3. CUMMING, R. E., and CHITTENDEN, G. E. Intravenous and retrograde urography. *J.A.M.A.*, 1936, 106, 602-606.
4. DOLAN, L. P. Allergic death due to intravenous use of diodrast. *J.A.M.A.*, 1940, 114, 138-139.
5. GOLDBURGH, H. L., and BAER, S. Death following the intravenous administration of diodrast. *J.A.M.A.*, 1942, 118, 1051-1052.
6. HYMAN, A. Intravenous urography in the diagnosis of urological diseases in childhood. *Surg., Gynec. & Obst.*, 1930, 51, 409-415.
7. KRETSCHMER, H. L. Intravenous urography. *Surg., Gynec. & Obst.*, 1930, 51, 404-408.
8. VON LICHTENBERG, A. Principles and new advances in excretion urography. *Brit. J. Urol.*, 1930, 2, 119.
9. MULLEN, E. A. Subcutaneous urography. *Pennsylvania Med. J.*, 1941, 44, 1447-1448.
10. PEARMAN, R. O. Technical considerations in excretory urography. *New England J. Med.*, 1943, 228, 507-508.
11. PENDERGRASS, E. P., CHAMBERLIN, G. W., GODFREY, E. W., and BURDICK, E. D. Survey of deaths and unfavorable sequelae following the administration of contrast media. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 741-762.
12. Queries and Minor Notes. Tuberculosis. *J.A.M.A.*, 1940, 114, 347.
13. Queries and Minor Notes. Reactions to urographic mediums. *J.A.M.A.*, 1947, 134, 651.
14. ROLNICK, H. C. Cystoscopy and urography. *Surg. Clin. North America*, 1941, 21, 135-151.
15. SUGAR, H. Intravenous urography with neo-iopax. *West. J. Surg.*, 1932, 40, 320-329.
16. WOLBARST, A. L., and HIRSCH, I. S. Intravenous urography. *Med. J. & Rec.*, 1930, 132, 1-6.



PHYSICAL CHARACTERISTICS OF SOFT ROENTGEN RAYS

By E. DALE TROUT, *and* R. M. GAGER

MILWAUKEE, WISCONSIN

INTRODUCTION

THE use of beryllium window roentgen tubes has expanded the roentgen-ray spectrum into regions not generally covered by existing literature. This paper is the report of an attempt to explore the physical characteristics of such radiation over the range of 30 to 100 kilovolts (peak). Any effort of this kind must of necessity be of a tentative nature because of the limited knowledge of certain elements involved. The least understood of these is probably the behavior of ionization chambers under such conditions. This is especially true of thimble chambers, which will probably go through some transition stages before a stage is arrived at wherein such instruments are as well understood and as reliable as is the case for their use with harder radiation. It may well be that chambers of the mesh type, the extrapolation chamber, or some future type of thimble chamber would have produced different results. Since none of these was available, the authors have attempted to obtain the best information with presently available facilities. Future developments in instrumentation may make it necessary to alter some of the information presented here. However, inasmuch as roentgen tubes of the type used for this experiment are coming into rather wide clinical and experimental use, it seemed worth while to present the best data that can be obtained under present conditions. That should at least make it possible for those working with such tubes to have some common information on which to base their work. Alterations can then be made as indicated by changes that may follow a fuller understanding of some of the elements involved.

EQUIPMENT

The equipment used throughout the period of about a year and a half during which these data were accumulated consisted of a self-rectified, self-contained, oil-immersed, 60 cycle unit, with a beryllium window tube having a window 2 millimeters thick and 1 inch in diameter. The usual precautions were taken for stabilizing voltage and tube current. The same precautions extended to timing apparatus and care in avoiding scattered radiation from supporting structures, room walls, etc.

INSTRUMENTS

It was felt that, so far as possible, the work should be done with some commercially available instrument, enabling its duplication by others interested in the problem. Accordingly, a 250 roentgen nylon chamber was obtained from the Victoreen Instrument Company. This chamber is commercially available and is designed to operate as part of the Victoreen condenser r-meter. The chamber was sent to the National Bureau of Standards for calibration against the Bureau's standard air chamber. The correction factors from this calibration were used throughout the investigation.

A standard air chamber was available for some of the work which had to be undertaken before a calibrated thimble chamber was available. It may be of interest to note that correction factors from 1.42 at 30 kv., unfiltered, to 1.10 at 100 kv. with 3 mm. of aluminum were necessary to bring this particular thimble chamber into agreement with the standard air chamber.

AIR ABSORPTION

In the use of radiation of conventional

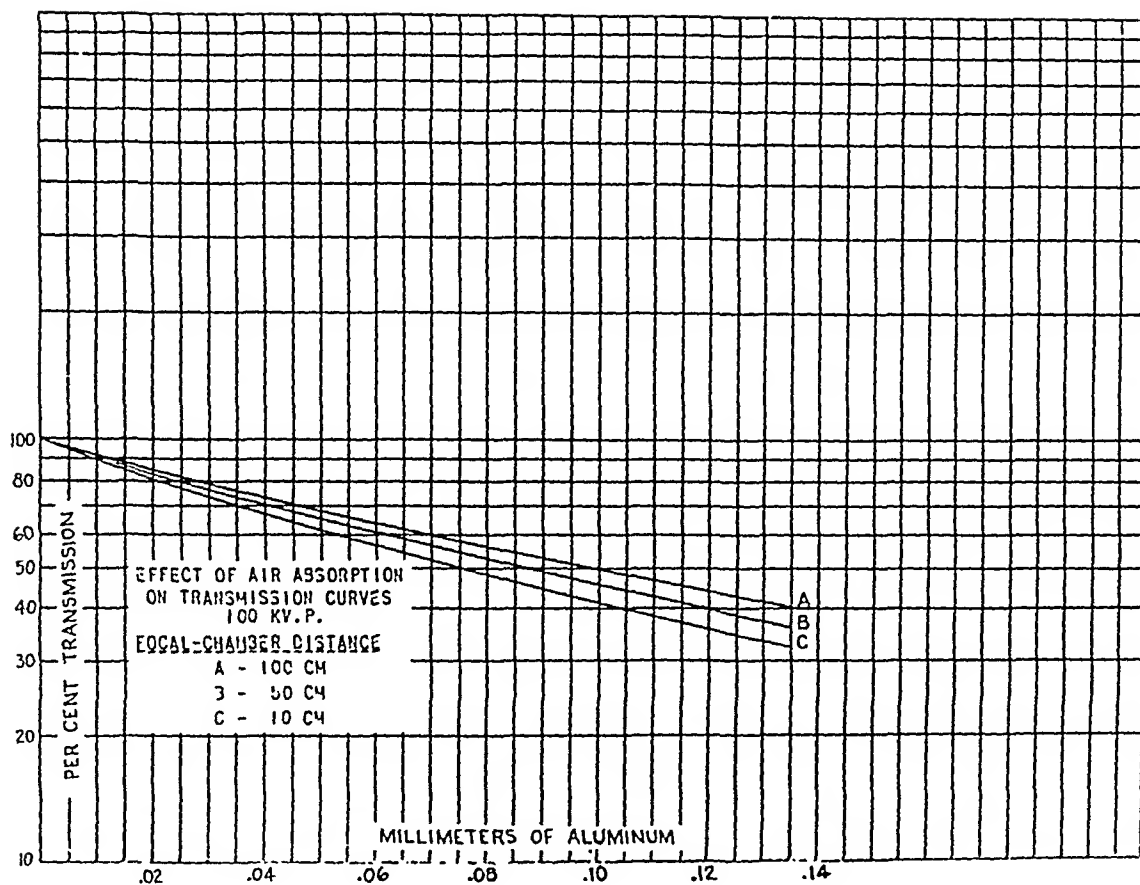


FIG. 1. Absorption curves in aluminum at 10, 50, and 100 centimeters.

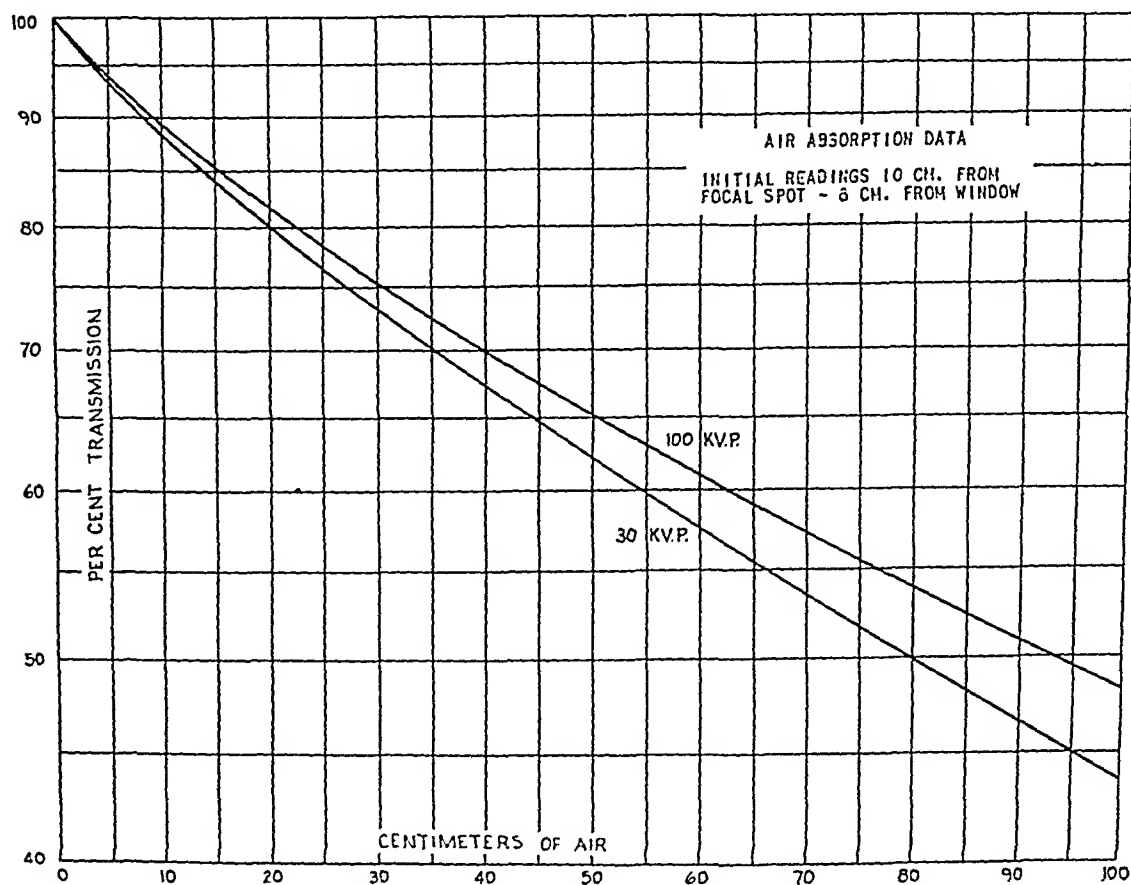


FIG. 2. Air absorption data.

quality, produced from glass-walled tubes at voltages above 60 kv. (peak), it has been general practice to ignore air absorption. That being the case, measurements taken at one distance can be computed for other

tances of 119 to 319 centimeters. Inasmuch as the equipment which we were using permitted focal-chamber distances as short as 10 cm., we had explored the problem for distances of 10 to 100 cm. Although it is

TABLE I
AIR ABSORPTION CORRECTION FACTOR FOR FOCAL-CHAMBER DISTANCES OF 10-100 CM.

30 kv. (peak)—Minimum Filtration										
From	To									
	10	12	15	20	25	30	40	50	70	100 cm.
10 cm.	1.00	0.98	0.94	0.88	0.84	0.80	0.73	0.67	0.58	0.46
12 cm.	1.02	1.00	0.96	0.90	0.86	0.82	0.75	0.68	0.59	0.47
15 cm.	1.06	1.04	1.00	0.94	0.89	0.85	0.78	0.71	0.62	0.49
20 cm.	1.13	1.11	1.07	1.00	0.96	0.91	0.83	0.76	0.66	0.52
25 cm.	1.19	1.16	1.12	1.05	1.00	0.95	0.87	0.80	0.69	0.55
30 cm.	1.25	1.22	1.17	1.10	1.05	1.00	0.91	0.84	0.73	0.57
40 cm.	1.37	1.34	1.29	1.20	1.15	1.09	1.00	0.92	0.80	0.63
50 cm.	1.49	1.46	1.40	1.31	1.25	1.19	1.09	1.00	0.87	0.69
70 cm.	1.72	1.69	1.62	1.52	1.45	1.38	1.26	1.15	1.00	0.79
100 cm.	2.17	2.13	2.04	1.91	1.82	1.74	1.59	1.45	1.26	1.00

100 kv. (peak)—Minimum Filtration										
From	To									
	10	12	15	20	25	30	40	50	70	100 cm.
10 cm.	1.00	0.98	0.94	0.89	0.85	0.81	0.75	0.70	0.61	0.51
12 cm.	1.02	1.00	0.96	0.91	0.87	0.83	0.77	0.71	0.62	0.52
15 cm.	1.06	1.04	1.00	0.95	0.90	0.86	0.80	0.74	0.65	0.54
20 cm.	1.12	1.10	1.05	1.00	0.95	0.91	0.84	0.79	0.69	0.57
25 cm.	1.17	1.15	1.10	1.05	1.00	0.95	0.88	0.82	0.72	0.60
30 cm.	1.23	1.21	1.16	1.10	1.05	1.00	0.93	0.87	0.75	0.63
40 cm.	1.33	1.30	1.25	1.18	1.13	1.08	1.00	0.93	0.81	0.68
50 cm.	1.43	1.40	1.34	1.27	1.21	1.16	1.07	1.00	0.87	0.73
70 cm.	1.64	1.60	1.54	1.46	1.39	1.33	1.23	1.15	1.00	0.84
100 cm.	1.96	1.92	1.84	1.74	1.66	1.59	1.47	1.37	1.20	1.00

distances by using the inverse-square law. This premise does not hold true when the inherent filtration is reduced to the point where the soft component of the beam is materially affected by absorption in a relatively short column of air. Fortunately, just as this paper was being prepared, a paper by Day and Taylor was published covering work on this problem for voltages from 7.5 to 200 kv. This excellent paper was concerned with focal-chamber dis-

difficult to get a direct comparison between Day and Taylor's data and ours, due to the fact that they were using constant potential and a tube having a 1.5 mm. beryllium window, there would seem to be fair agreement between our data at 100 centimeters and that of Day and Taylor at 119 cm. when the differences in apparatus are taken into consideration.

Day and Taylor reported little change in the quality of the beam after it had been

attenuated by 119 cm. of air. They pointed out that changes in the quality of the beam might be expected at distances less than 1 meter. Their prediction is in keeping with our findings. In Figure 1 are plotted three absorption curves in aluminum taken at 100 kv. (peak) at focal-chamber distances of 10, 50, and 100 cm. It will be noted that the half-value layers at these distances are

cm.⁻¹ for 100 kv., where the inherent filtration was 1.5 mm. of beryllium plus 119 cm. of air, and where the tube was energized by constant potential.

In Table 1 will be found the correction factor for air absorption for 30 and 100 kv. (peak) for a tube having a 2 mm. beryllium window 4 cm. from the focal spot. If the inverse-square law is used to compute the

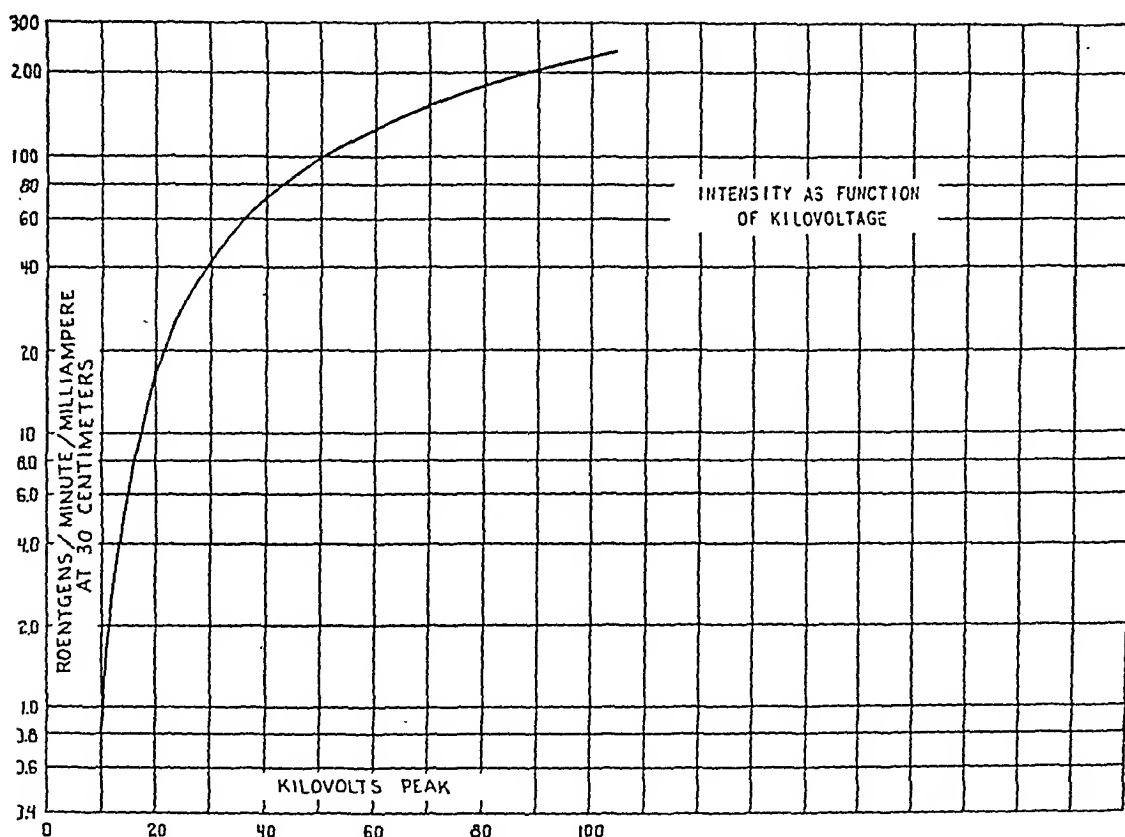


FIG. 3. Intensity as function of kilovoltage.

0.075, 0.086, and 0.10 mm. of aluminum, respectively. In Figure 2 are plotted absorption curves in air for focal-chamber distances of 10 to 100 cm. It should be noted that at the 10 cm. focal-chamber distance, there are only 6 cm. of air between the chamber and the window, since the focal-window distance was 4 centimeters.

If our data, taken between 90 and 100 cm. from the focal spot, are used to compute the linear absorption coefficient, the result is 6.76×10^{-3} cm.⁻¹ for 30 kv. and 5.73×10^{-3} cm.⁻¹ for 100 kv. These would compare with Day and Taylor's values of 6.1×10^{-3} cm.⁻¹ for 30 kv., and 5.1×10^{-3}

intensity, the computed value must be multiplied by this correction factor.

INTENSITY OF RADIATION

The intensity of radiation from tubes of this type is much higher than that encountered with tubes having glass windows. In Figure 3, the intensity at a 30 cm. focal-chamber distance is plotted for voltages from 10 to 100 kv. (peak). It will be noted that a very slight change in voltage between 10 and 30 kv. produces a great change in intensity. For that reason, at voltages below 30 kv. (peak) better than average conditions must prevail in the way of stable line voltage if the intensity is to

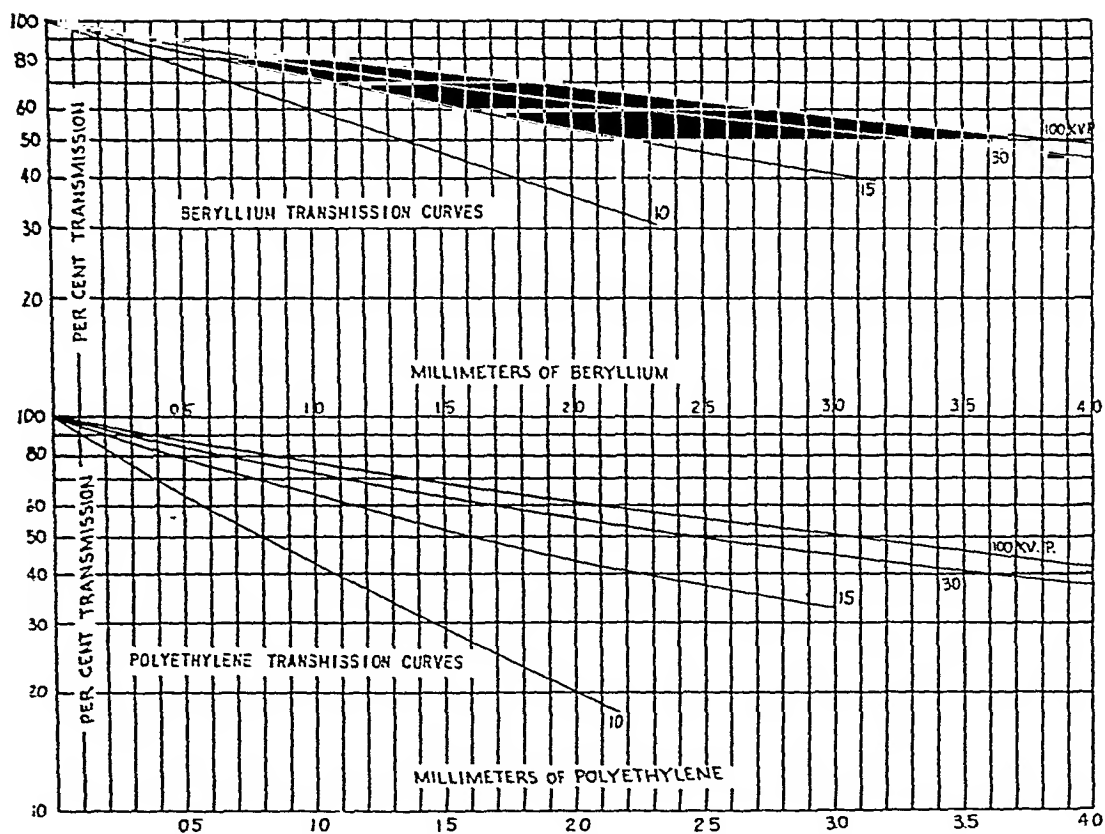


FIG. 4. Transmission curves in beryllium and polyethylene.

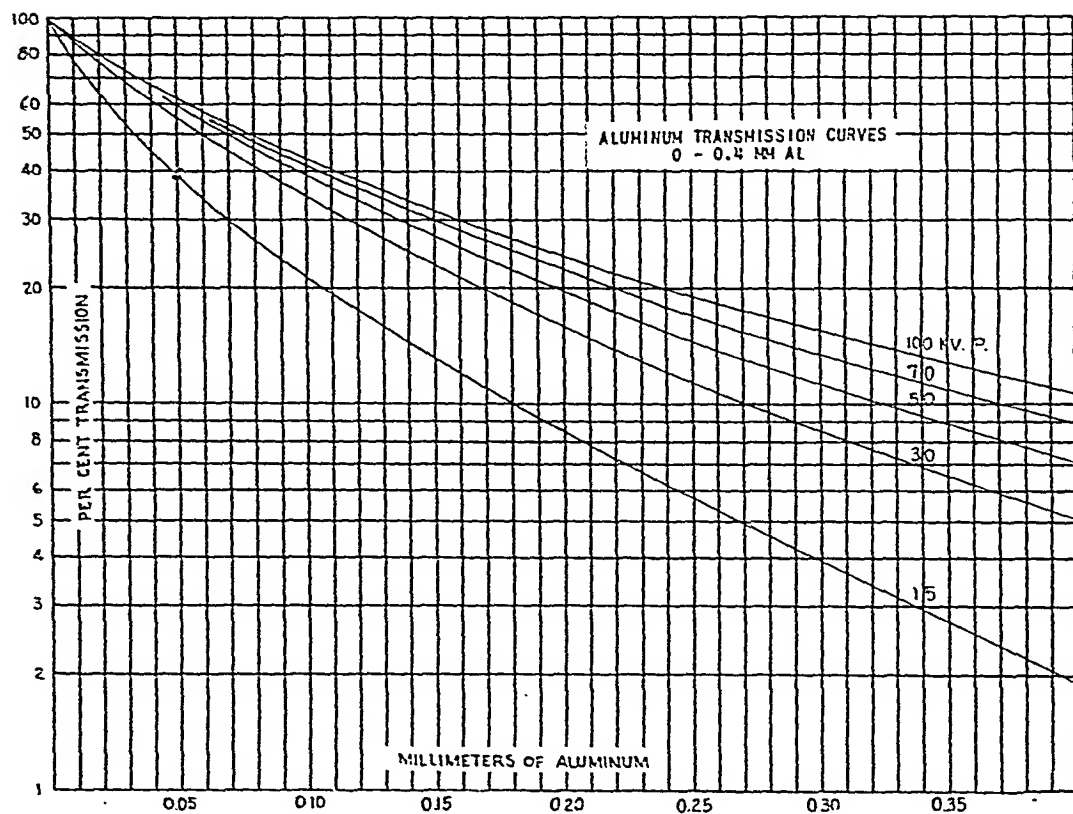


FIG. 5. Transmission curves in aluminum; 0-0.4 mm. aluminum.

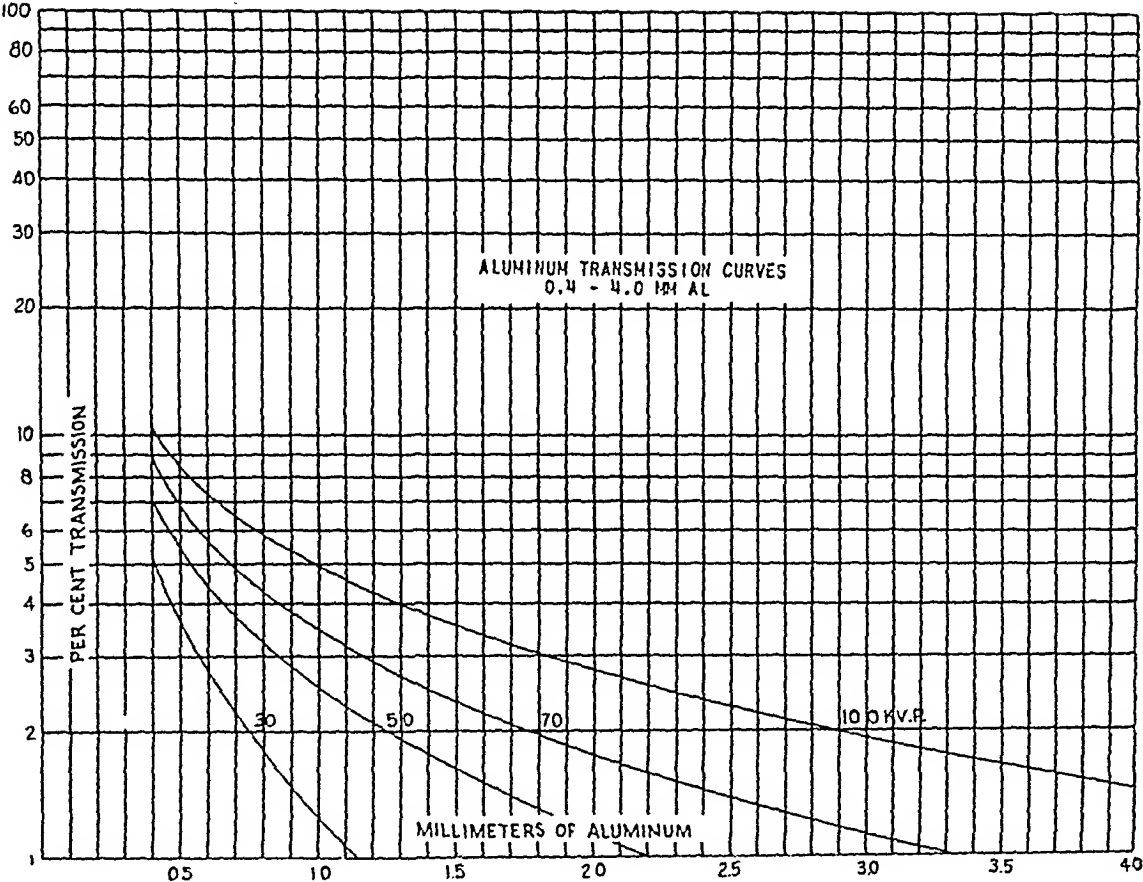


FIG. 6. Transmission curves in aluminum; 0.4-4 mm. aluminum.

TABLE II
QUALITY OF RADIATION

Kv. (peak)	Filter	Half-Value Layer (nominal)	
10	Minimum	1.35	mm. beryllium
15	Minimum	2.21	mm. beryllium
30	Minimum	3.33	mm. beryllium
100	Minimum	3.85	mm. beryllium
10	Minimum	0.80	mm. polyethylene
15	Minimum	1.60	mm. polyethylene
30	Minimum	2.45	mm. polyethylene
100	Minimum	3.05	mm. polyethylene
30	Minimum	0.060	mm. Al
50	Minimum	0.070	mm. Al
70	Minimum	0.076	mm. Al
85	Minimum	0.078	mm. Al
100	Minimum	0.080	mm. Al
85	0.25 mm. Al	0.23	mm. Al
100	0.25 mm. Al	0.25	mm. Al
85	0.50 mm. Al	0.68	mm. Al
100	0.50 mm. Al	0.78	mm. Al
100	1.00 mm. Al	1.30	mm. Al
100	2.00 mm. Al	2.10	mm. Al
100	3.00 mm. Al	3.10	mm. Al

be controlled within workable limits for experimental or clinical work. That being the case, the greater part of this report will deal with voltages of 30 kv. or more.

TRANSMISSION DATA

One of the first difficulties encountered in taking absorption curves for very soft radiation is the matter of suitable filter material. Aluminum filters become so thin that it is difficult to be sure of uniformity, and it also becomes difficult to measure the thickness by conventional methods. Great care must be exercised in the selection of material of pure composition. One of the widely used aluminum alloys contains 4 per cent of copper. Filters of this material will give readings approximately 30 per cent less than filters of pure aluminum.

For certain laboratory work, it was felt advisable to take absorption data with something other than aluminum. Accordingly, beryllium and polyethylene were used. Finally absorption curves were plotted

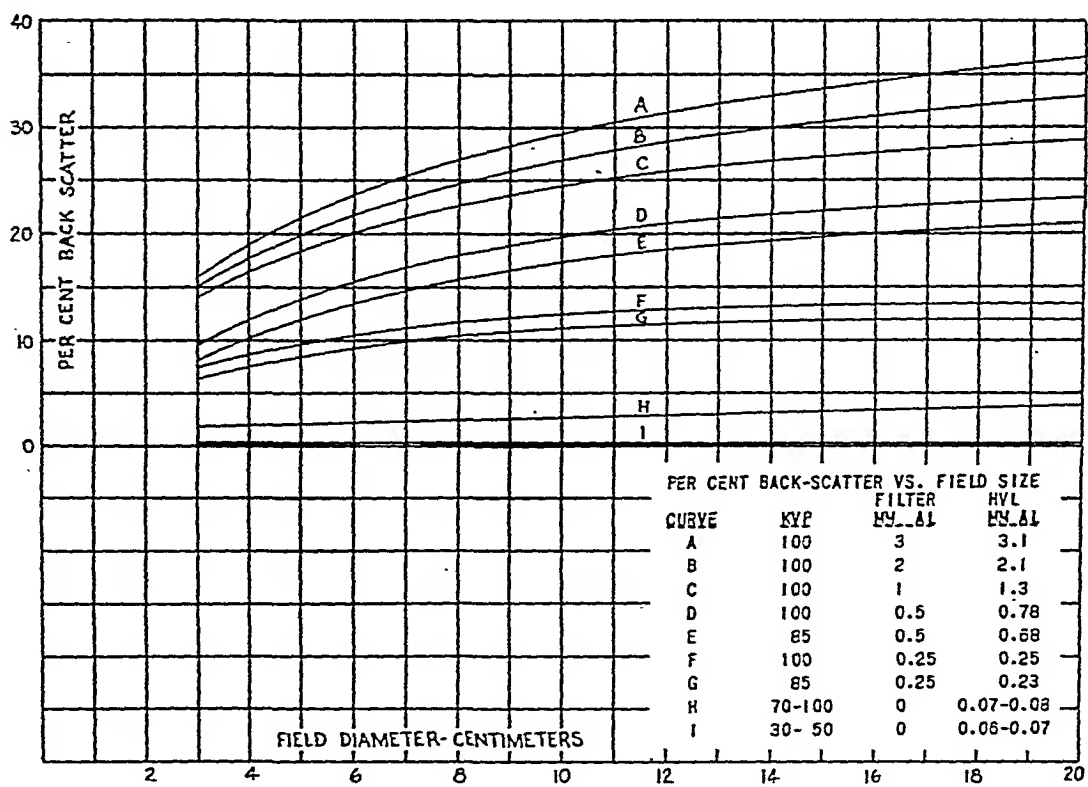


FIG. 7. Backscatter data.

in aluminum. This work was done using a standard air chamber at a distance of 30 cm. Transmission curves for beryllium, polyethylene and aluminum are shown in Figures 4, 5, and 6. From the transmission data, the nominal half-value layers were determined and are listed in Table II. The actual half-value layer may deviate slightly from these values at distances other than 30 centimeters. However, since distances

TABLE III
BACKSCATTER DATA

Kv. (peak)	Filter mm. Al	Half-Value Layer mm. Al	Per Cent Backscatter					cm. diam. field sq. cm. area
			3 7.06	5 19.6	10 78.5	15 177	20 314	
30	0	0.06	0	0	0	0	0	
50	0	0.07	0	0	0	0	0	
70	0	0.07	2	2	3	3	4	
85	0	0.08	2	2	3	3	4	
	0.25	0.23	6	8	11	11	12	
	0.50	0.68	8	12	17	20	21	
100	0	0	2	2	3	3	4	
	0.25	0.25	7	9	12	13	13	
	0.50	0.78	9	13	19	22	23	
	1.0	1.3	13	18	24	27	29	
	2.0	2.1	14	20	27	30	33	
	3.0	3.1	15	21	29	33	36	

of 10 to 30 cm. will be used for most clinical applications, the nominal half-value layers are probably adequate.

BACKSCATTER

In investigating backscatter and depth dose, it seemed advisable to use material approaching tissue as nearly as possible since work of other investigators had shown that some of the more common phantom materials, when used at low voltages, gave results that were not comparable with tissue. After considerable thought and experiment, it was decided to use beef. A section of lean beef 30 cm. in diameter and 7.5 cm. thick was used for backscatter measurements. A strip of tissue was removed, just permitting the chamber to be half buried. The refrigerating facilities that were available made it possible to maintain the moisture content of the meat at a uniform value. The results obtained were plotted in Figure 7 and arranged for ready reference in Table III. No attempt was made to consider backscatter of less than 2 per cent, since it was felt that the conditions under which the work was done did not make such figures significant.

The results were about as expected, with virtually no backscatter at the lower voltages. As voltages and filtration were increased, the backscatter became equal to that obtained with conventional sources. At higher voltage and filtration, the results are comparable with those of other investigators.

DEPTH DOSE

Sections of beef as described above were used for depth dose measurements. A 7.5 cm. thick section, 30 cm. in diameter was maintained below the thimble chamber at all times. A high-speed slicer was used to cut sections 1, 2 and 4 mm. in thickness. Combinations of these were used to obtain thicker sections. Care was taken to shape the tissue closely around the chamber at all times.

Repeated checks indicated that it was possible to leave the chamber in the electrometer without introducing appreciable error due to radiation penetrating the electrometer. This eliminated the errors brought about by repositioning the chamber in the tissue.

The data obtained are plotted in Figures 8 through 19. For comparative study, the

TABLE IV
DEPTH DOSE FOR 30 KV. (PEAK), NO FILTER (HALF-VALUE LAYER 0.06 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	31	31	31	31	—	—	—	
2	20	20	20	20	—	—	—	
4	10	10	10	10	—	—	—	
8	4	4	4	4	—	—	—	
12	2	2	2	2	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	33	33	—	33	33	33	
2	—	21	21	—	21	21	21	
4	—	11	11	—	11	11	11	
8	—	4	4	—	4	4	4	
12	—	2	2	—	2	2	2	

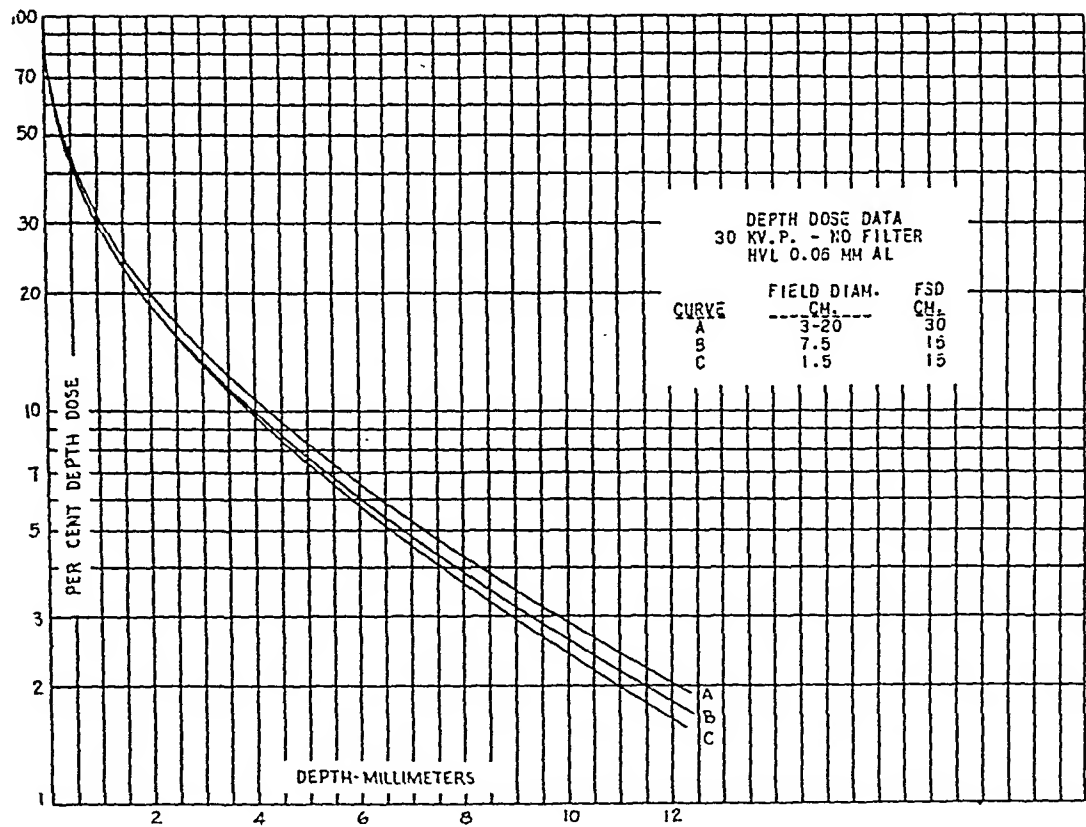


FIG. 8. Depth dose data; 30 kv. (peak); no filter.

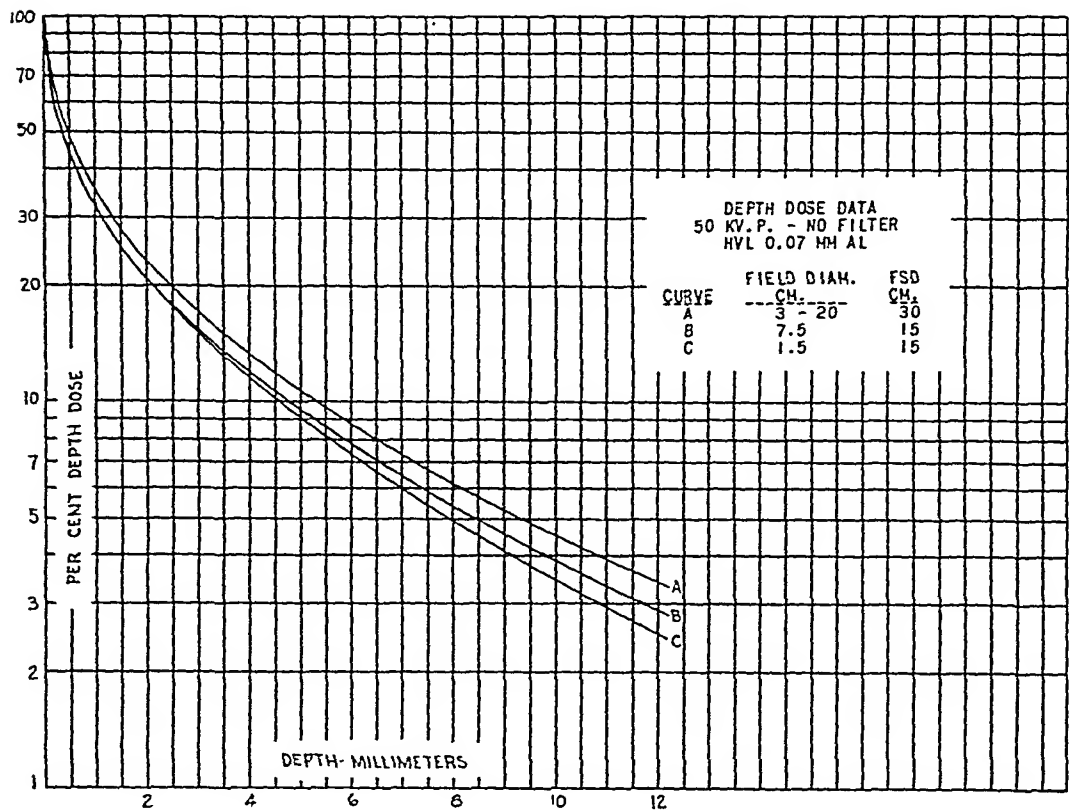


FIG. 9. Depth dose data; 50 kv. (peak); no filter.

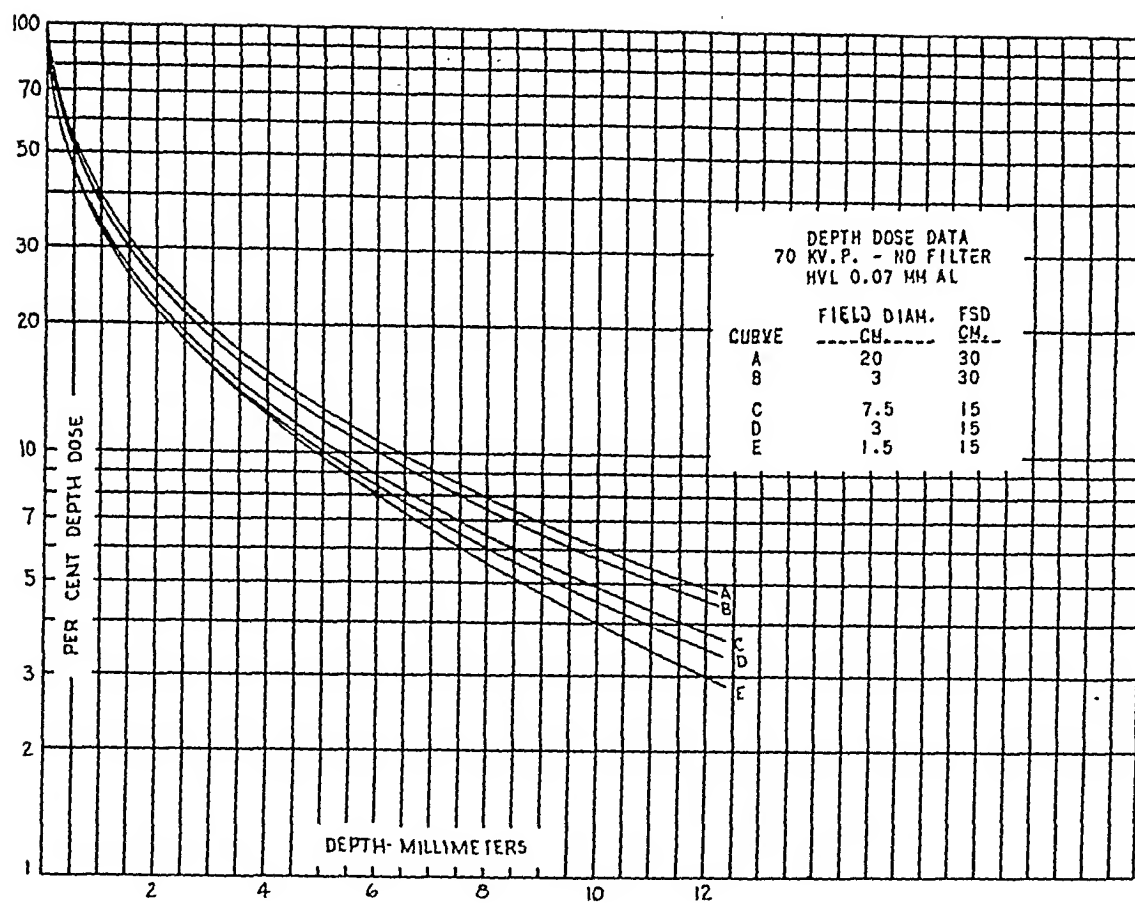


FIG. 10. Depth dose data; 70 kv. (peak); no filter.

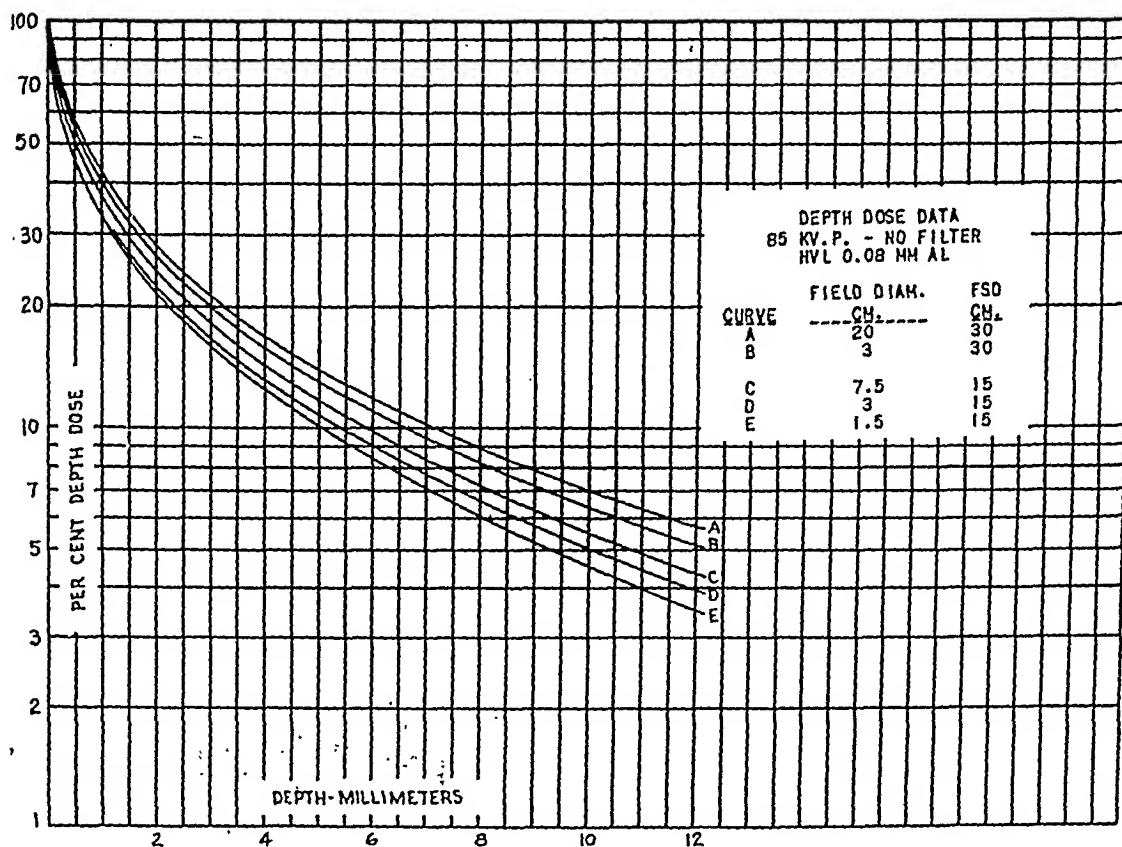


FIG. 11. Depth dose data; 85 kv. (peak); no filter.

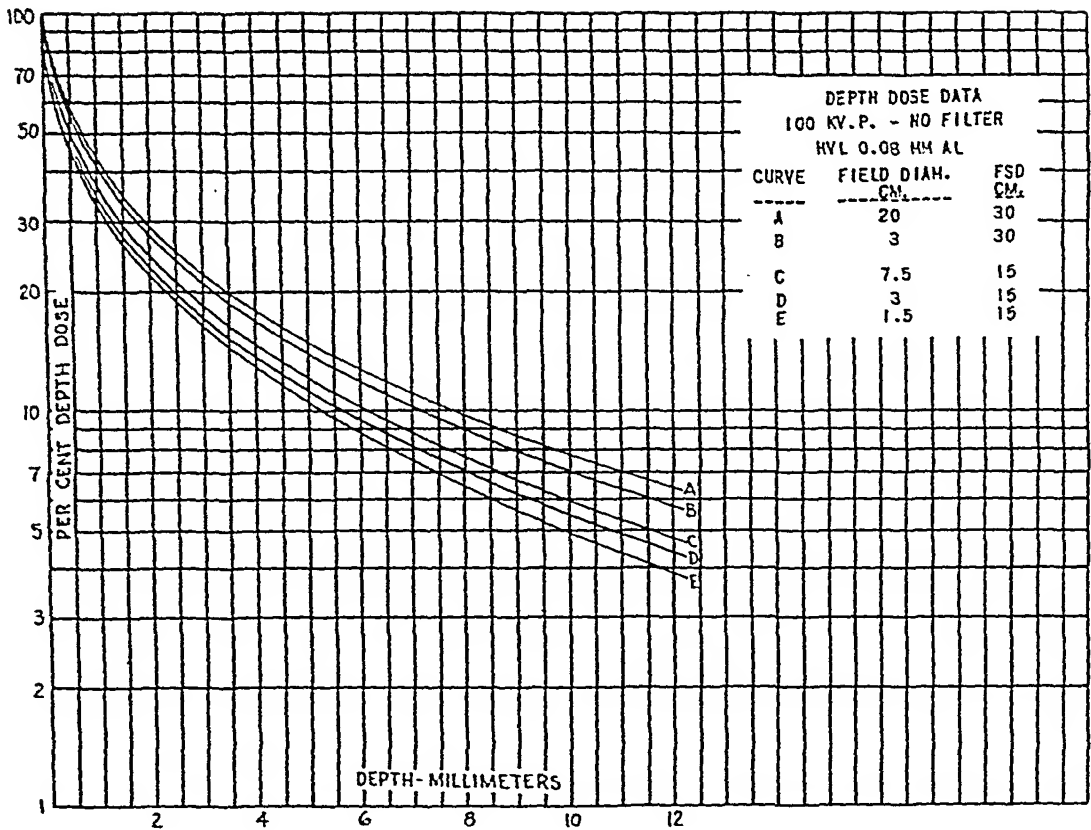


FIG. 12. Depth dose data; 100 kv. (peak); no filter.

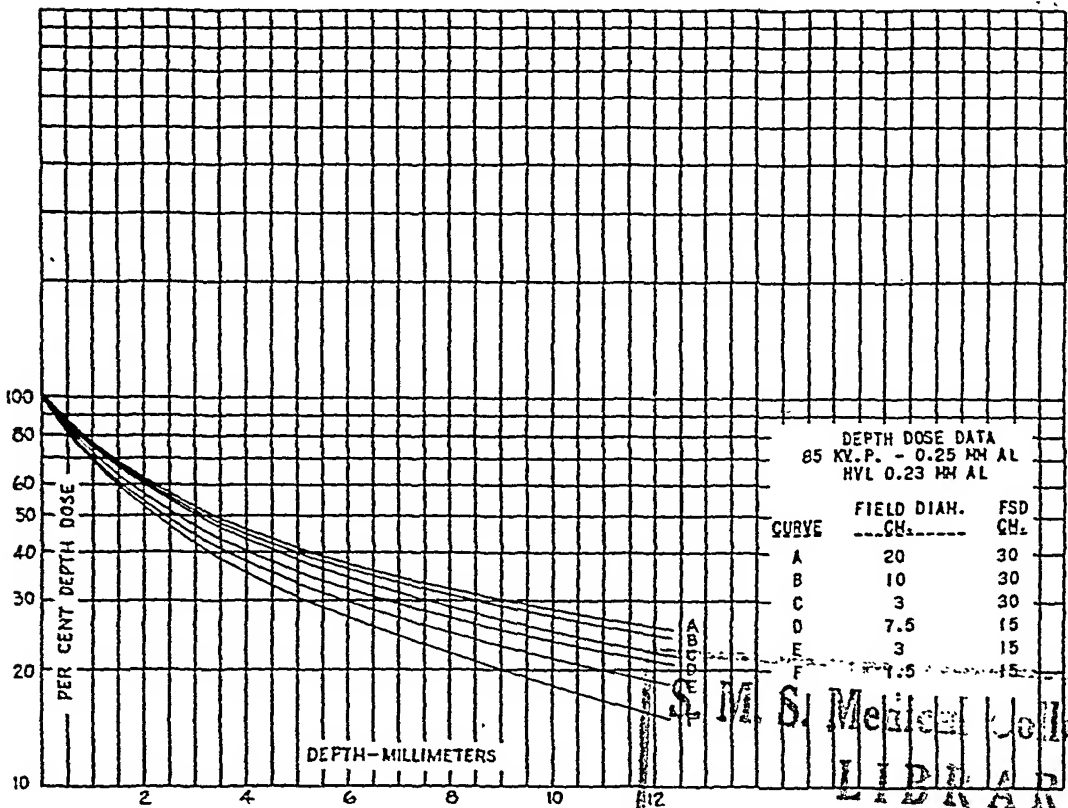


FIG. 13. Depth dose data; 85 kv. (peak); 0.25 mm. Al.

Acc. No.
Cl. No.
Date of Acc.

S. M. S. Medical College, Jaipur
LIBRARY

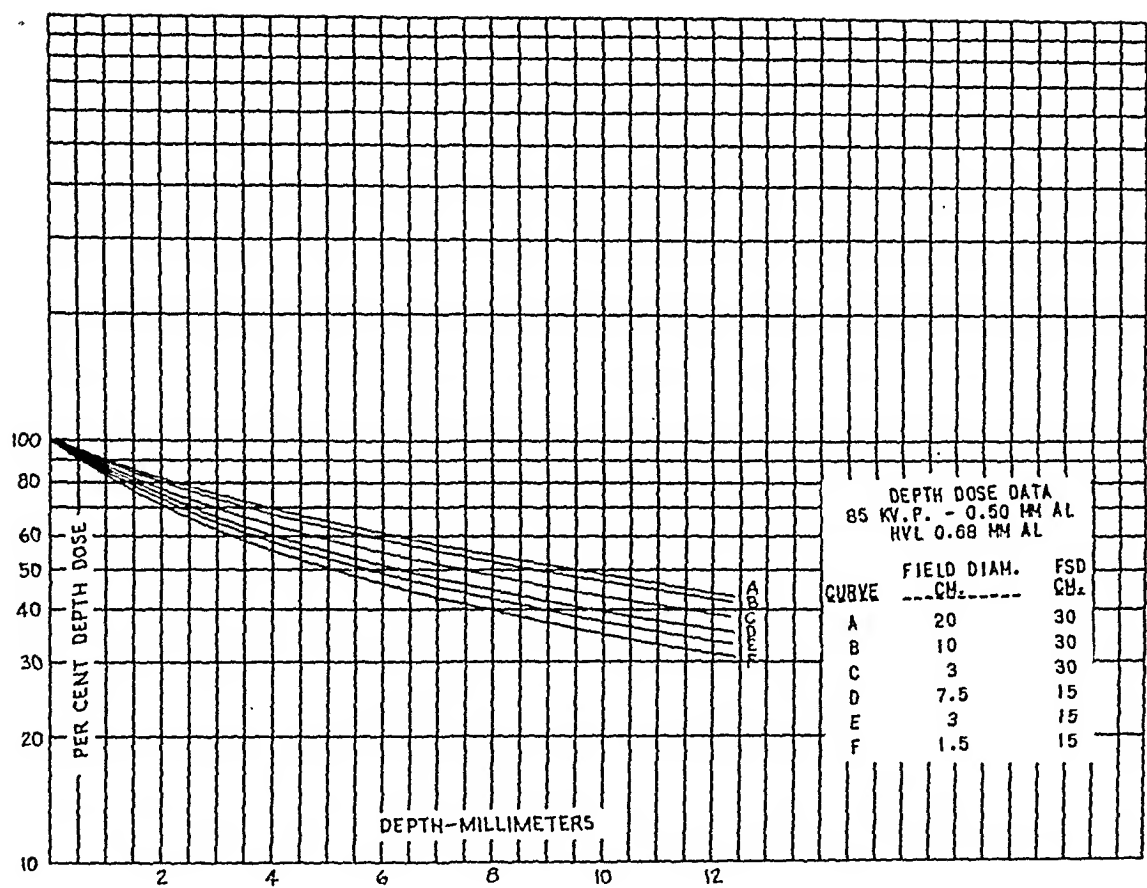


FIG. 14. Depth dose data; 85 kv. (peak); 0.50 mm. Al.

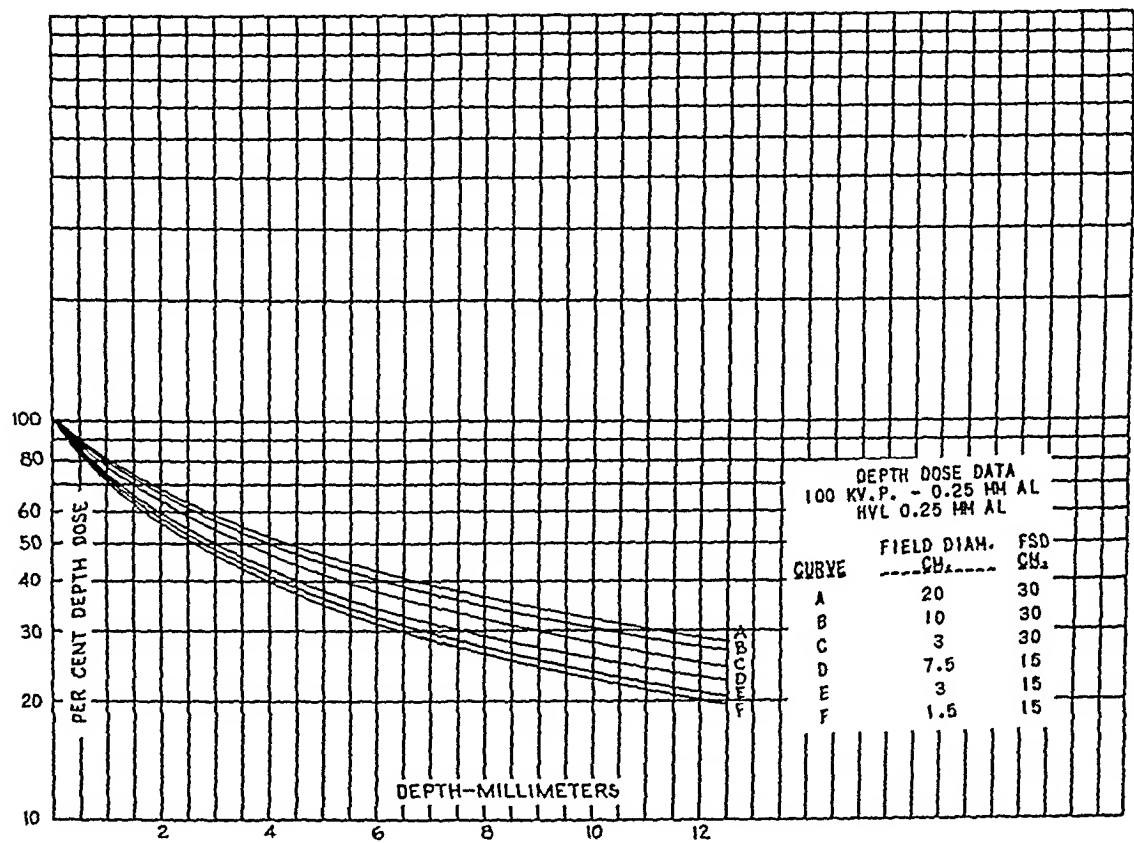


FIG. 15. Depth dose data; 100 kv. (peak); 0.25 mm. Al.

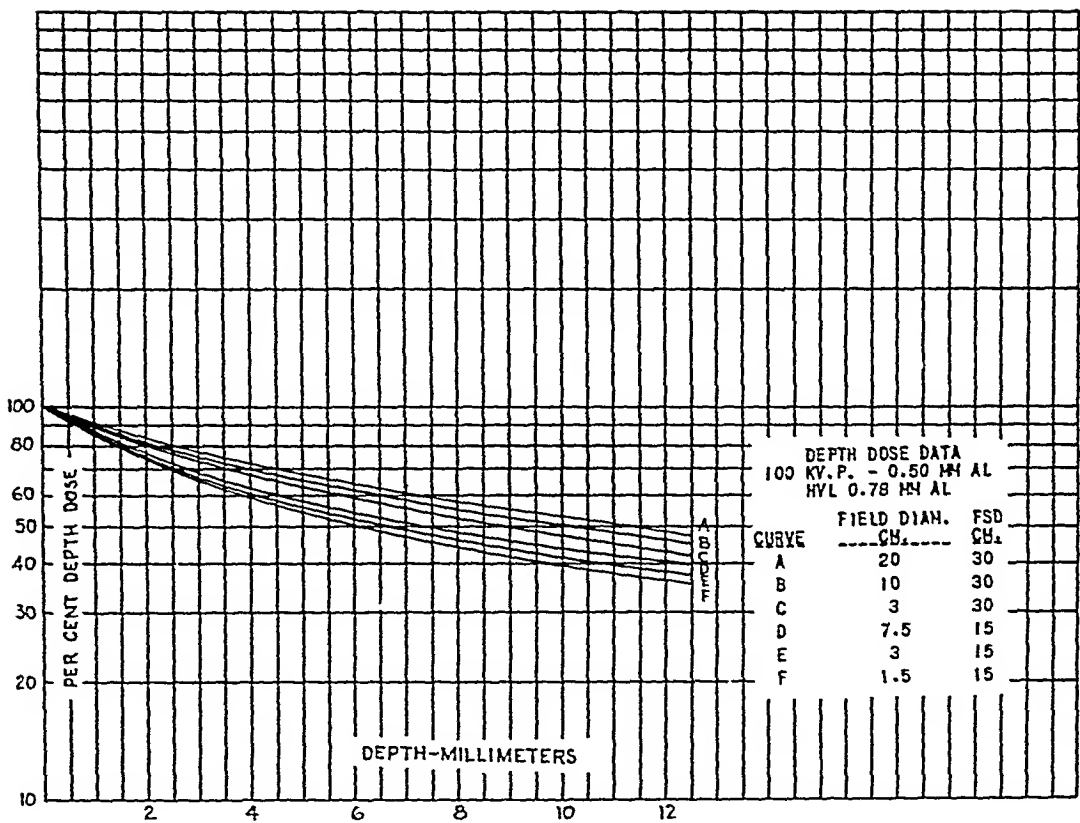


FIG. 16. Depth dose data; 100 kv. (peak); 0.50 mm. Al.

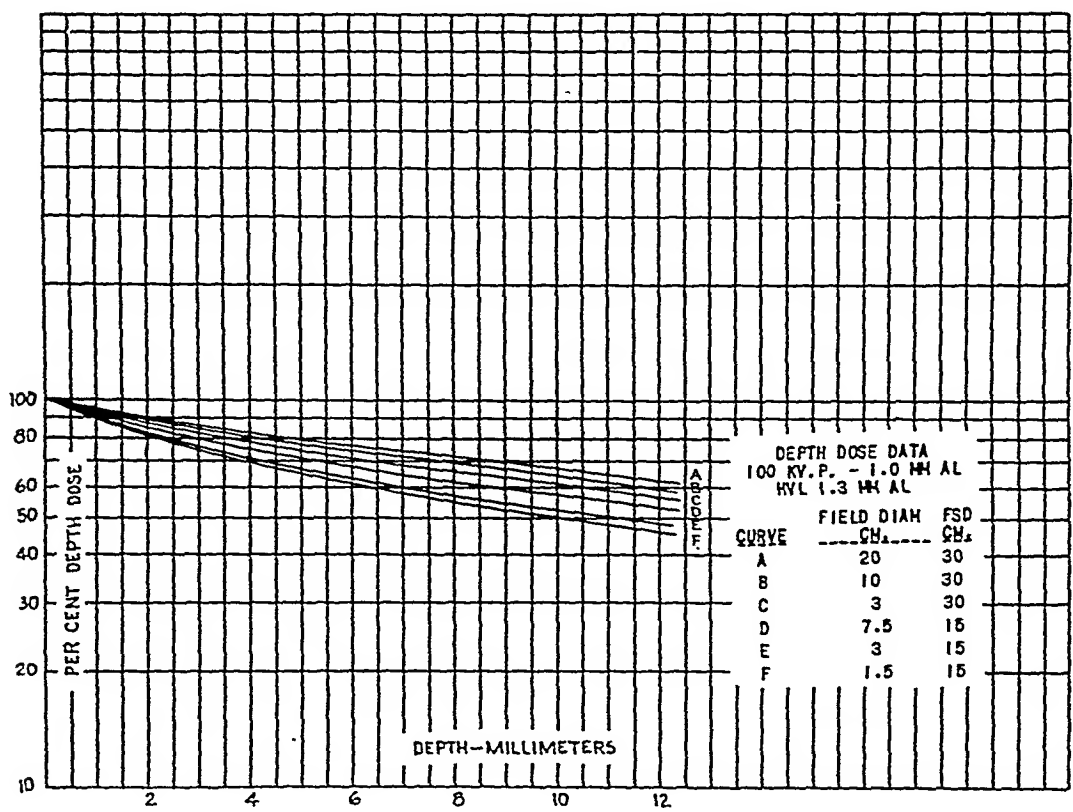


FIG. 17. Depth dose data; 100 kv. (peak); 1.00 mm. Al.

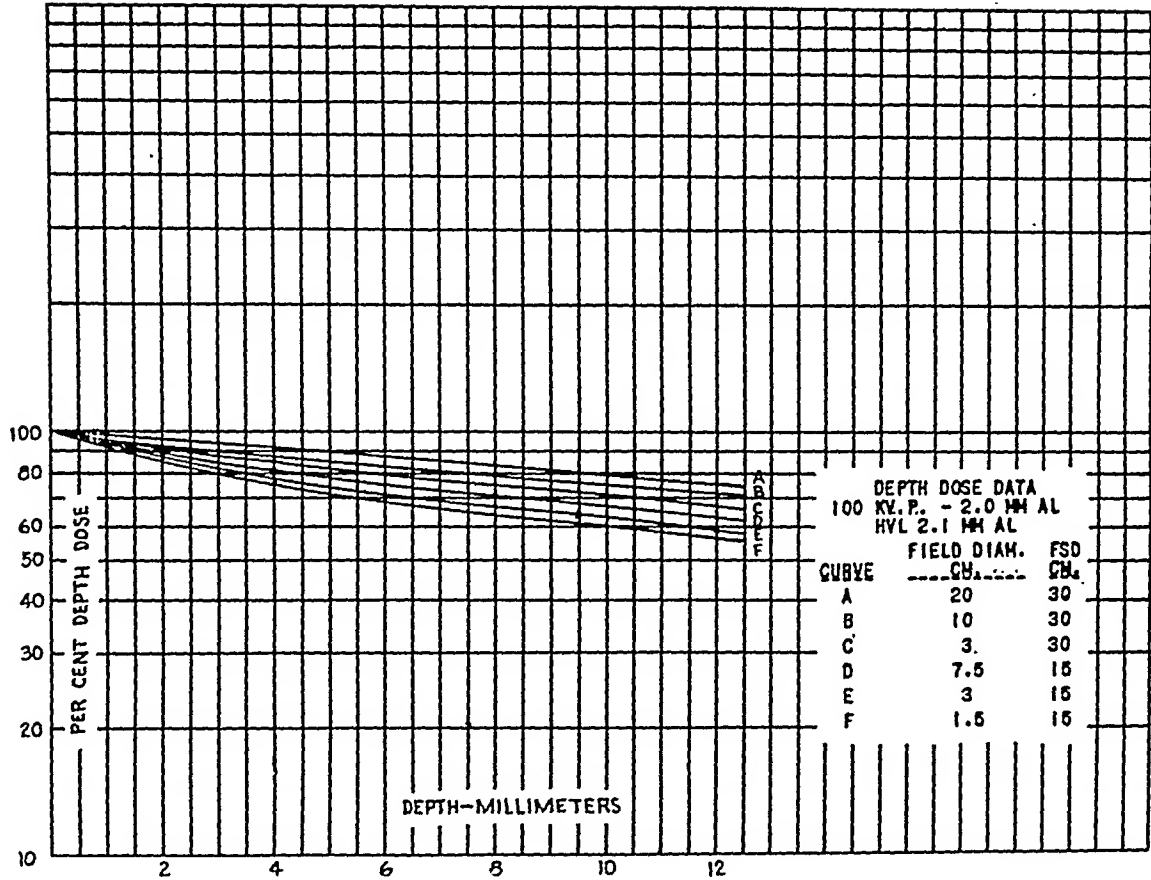


FIG. 18. Depth dose data; 100 kv. (peak); 2.00 mm. Al.

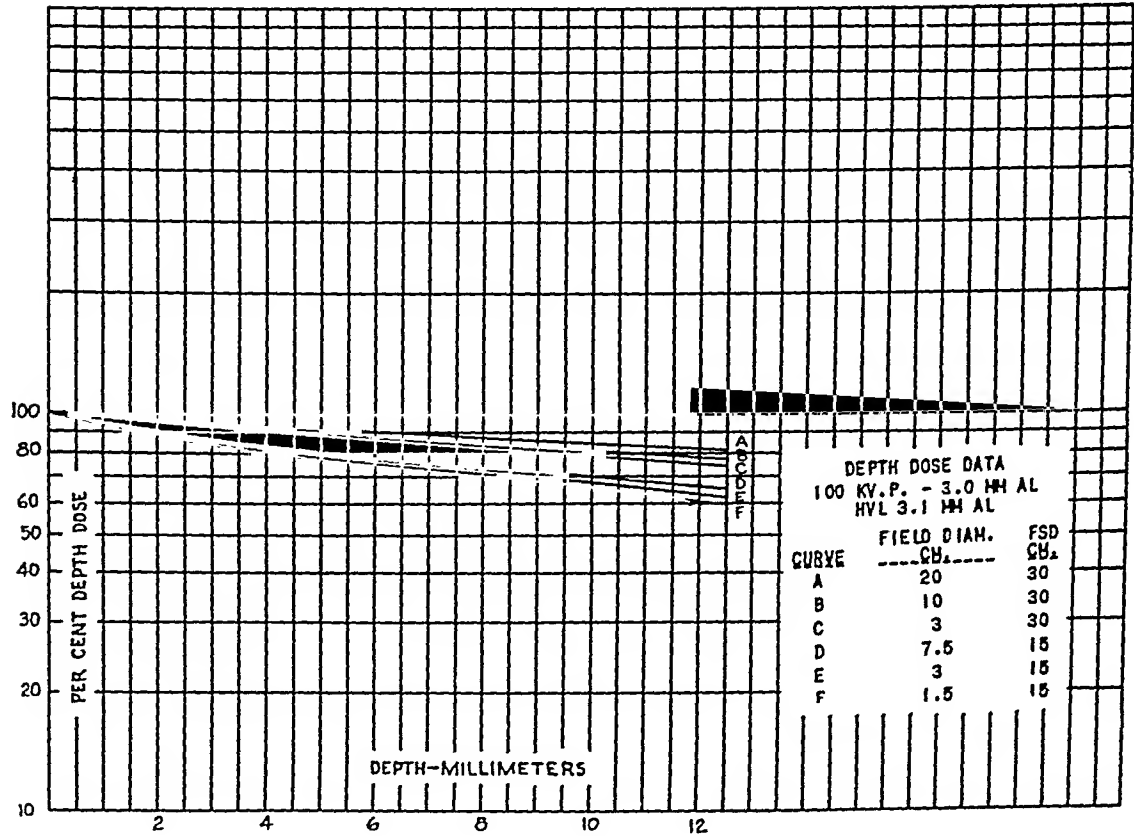


FIG. 19. Depth dose data; 100 kv. (peak); 3.00 mm. Al.

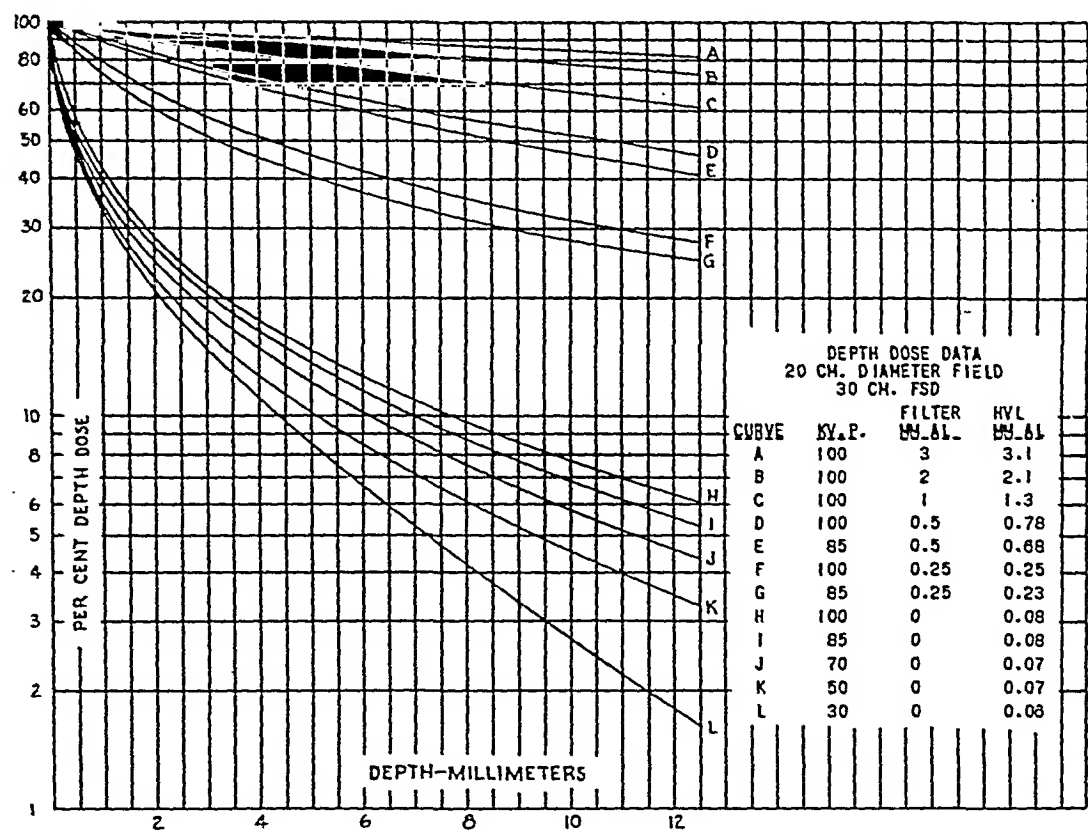


FIG. 20. Comparative depth dose data.

TABLE V

DEPTH DOSE FOR 50 KV. (PEAK), NO FILTER (HALF-VALUE LAYER 0.07 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	33	33	33	33	—	—	—	
2	21	21	21	21	—	—	—	
4	12	12	12	12	—	—	—	
8	5	5	5	5	—	—	—	
12	3	3	3	3	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	35	36	—	36	36	36	
2	—	23	23	—	24	24	24	
4	—	13	13	—	13	13	13	
8	—	6	6	—	6	6	6	
12	—	3	3	—	3	3	3	

data for a 20 cm. diameter field at 30 cm. focal-skin distance over the entire quality range have been plotted in Figure 20. It will be noted that there is a considerable

unexplored range between 100 kv. with no filter and 85 kv. with 0.25 mm. of aluminum. If clinical experience indicates that it is desirable to use some quality between

TABLE VI
DEPTH DOSE FOR 70 KV. (PEAK), NO FILTER (HALF-VALUE LAYER 0.07 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	33	33	33	34	—	—	—	
2	21	22	22	3	—	—	—	
4	12	12	13	13	—	—	—	
8	5	6	6	6	—	—	—	
12	3	4	4	4	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	38	38	—	39	39	39	
2	—	25	25	—	26	26	26	
4	—	15	15	—	15	15	15	
8	—	8	8	—	8	8	8	
12	—	5	5	—	5	5	5	

those obtained with no filter and 0.25 mm. of aluminum, it would probably be advisable to resort to filters of some plastic material such as polyethylene to reduce the hazards associated with foil-type metal filters.

For ready reference, depth dose data for the conditions studied are arranged in Tables iv through xv. A rapid comparison of the depth dose for the various conditions can be had by reference to Table xvi, wherein is collected the depth dose 4 mm. below the surface for the various conditions.

TABLE VII
DEPTH DOSE FOR 85 KV. (PEAK), NO FILTER (HALF-VALUE LAYER 0.08 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77 1.5	7.06 3	19.6 5	44.1 7.5	78.5 10	177 15	314 20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	34	35	35	36	—	—	—	
2	22	23	23	24	—	—	—	
4	13	13	14	14	—	—	—	
8	6	7	7	7	—	—	—	
12	4	4	4	4	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	40	41	—	42	42	42	
2	—	27	27	—	28	28	28	
4	—	16	16	—	17	17	17	
8	—	8	9	—	9	9	9	
12	—	5	6	—	6	6	6	

TABLE VIII
DEPTH DOSE FOR 100 KV. (PEAK), NO FILTER (HALF-VALUE LAYER 0.08 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. are cm. diam.
	1.77 1.5	7.06 3	19.6 5	44.1 7.5	78.5 10	177 15	314 2	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	34	36	36	37	—	—	—	
2	23	24	24	25	—	—	—	
4	13	14	14	15	—	—	—	
8	7	7	7	8	—	—	—	
12	4	4	5	5	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	42	43	—	43	44	44	
2	—	28	29	—	29	29	29	
4	—	17	18	—	18	18	18	
8	—	9	10	—	10	10	10	
12	—	6	6	—	6	6	6	

TABLE IX
DEPTH DOSE FOR 85 KV. (PEAK), 0.25 MM. AL (HALF-VALUE LAYER 0.23 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77 1.5	7.06 3	19.6 5	44.1 7.5	78.5 10	177 15	314 20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	68	70	70	71	—	—	—	
2	52	54	55	56	—	—	—	
4	36	38	39	40	—	—	—	
8	23	25	26	27	—	—	—	
12	17	19	20	21	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	76	76	—	76	76	76	
2	—	61	61	—	61	61	61	
4	—	44	45	—	45	46	46	
8	—	29	30	—	31	32	32	
12	—	22	23	—	25	26	26	

TABLE X
DEPTH DOSE FOR 85 KV. (PEAK), 0.50 MM. AL (HALF-VALUE LAYER 0.68 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	83	84	84	85	—	—	—	
2	72	73	74	74	—	—	—	
4	56	58	59	60	—	—	—	
8	40	43	44	45	—	—	—	
12	31	34	35	36	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	88	89	—	90	90	90	
2	—	78	79	—	81	82	82	
4	—	65	67	—	69	70	70	
8	—	49	51	—	53	53	54	
12	—	39	41	—	42	43	43	

TABLE XI
DEPTH DOSE FOR 100 KV. (PEAK), 0.25 MM. AL (HALF-VALUE LAYER 0.25 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	71	72	72	74	—	—	—	
2	56	57	58	59	—	—	—	
4	40	41	42	43	—	—	—	
8	27	27	28	29	—	—	—	
12	20	21	22	23	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	78	78	—	79	80	80	
2	—	63	65	—	66	67	67	
4	—	47	49	—	50	51	51	
8	—	32	33	—	35	36	36	
12	—	25	26	—	28	29	29	

TABLE XII
DEPTH DOSE FOR 100 KV. (PEAK), 0.50 MM. AL (HALF-VALUE LAYER 0.78 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77 1.5	7.06 3	19.6 5	44.1 7.5	78.5 10	177 15	314 20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	86	86	87	88	—	—	—	
2	75	76	77	78	—	—	—	
4	60	62	63	64	—	—	—	
8	45	47	48	49	—	—	—	
12	36	37	39	40	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	90	90	—	90	91	92	
2	—	82	82	—	83	84	84	
4	—	69	69	—	71	73	73	
8	—	54	54	—	56	58	58	
12	—	43	45	—	46	47	47	

TABLE XIII
DEPTH DOSE FOR 100 KV. (PEAK), 1.0 MM. AL (HALF-VALUE LAYER 1.3 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	90	90	92	92	—	—	—	
2	82	83	86	86	—	—	—	
4	70	72	75	76	—	—	—	
8	56	58	61	62	—	—	—	
12	47	49	52	53	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	93	94	—	95	95	95	
2	—	88	89	—	90	90	91	
4	—	79	81	—	82	83	83	
8	—	66	68	—	70	71	72	
12	—	56	58	—	60	61	62	

TABLE XIV
DEPTH DOSE FOR 100 KV. (PEAK), 2.0 MM. AL (HALF-VALUE LAYER 2.1 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7.5	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	93	93	94	94	—	—	—	
2	87	88	89	90	—	—	—	
4	78	79	80	81	—	—	—	
8	65	67	69	71	—	—	—	
12	57	59	61	63	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	97	97	—	97	97	98	
2	—	94	94	—	95	95	96	
4	—	87	88	—	89	90	91	
8	—	76	78	—	80	81	82	
12	—	66	69	—	71	73	75	

TABLE XV
DEPTH DOSE FOR 100 KV. (PEAK), 3.0 MM. AL (HALF-VALUE LAYER 3.1 MM. AL)

Depth mm.	Per Cent Depth Dose							sq. cm. area cm. diam.
	1.77	7.06	19.6	44.1	78.5	177	314	
	1.5	3	5	7	10	15	20	
Focal-skin distance = 15 cm.								
0	100	100	100	100	—	—	—	
1	94	95	95	95	—	—	—	
2	90	91	91	91	—	—	—	
4	82	83	84	84	—	—	—	
8	70	73	74	75	—	—	—	
12	60	63	66	67	—	—	—	
Focal-skin distance = 30 cm.								
0	—	100	100	—	100	100	100	
1	—	97	98	—	98	98	98	
2	—	95	96	—	96	96	97	
4	—	90	92	—	92	93	94	
8	—	82	85	—	85	86	87	
12	—	75	78	—	79	80	81	

TABLE XVI
COMPARISON OF DEPTH DOSE DATA

Kv. (Peak)	Filter mm. Al	Half-Value Layer mm. Al	Per Cent of Surface Dose 4 mm. Below Surface		
			1.5 cm. 15 cm.	20 cm. 30 cm.	field diam. focal-skin distance
30	0	0.06	10	11	
50	0	0.07	12	13	
70	0	0.07	12	15	
85	0	0.08	13	17	
	0.25	0.23	36	46	
	0.50	0.68	56	70	
100	0	0.08	13	18	
	0.25	0.25	40	51	
	0.50	0.78	60	73	
	1.0	1.3	70	83	
	2.0	2.1	78	91	
	3.0	3.1	82	94	

SUMMARY

A study of the physical characteristics of the radiation from a roentgen tube having a 2 millimeter beryllium-to-air window and operating from 10 to 100 kilovolts (peak) is reported.

This report covers the instruments used, failure of the inverse-square law due to air absorption; change in quality due to air absorption at short distances; transmission curves in beryllium, polyethylene, and aluminum; backscatter data and depth dose information for radiation quality from a half-value layer of 0.06 millimeter of aluminum to 3.1 millimeters of aluminum.

It will be noted that with unfiltered radiation very little change in quality, backscatter, or depth dose is produced by a change in voltage. A marked difference in quality, backscatter, and depth dose is produced by the addition of a minimum amount of filter.

The depth dose information indicates the clinical possibilities of very soft radiation in those conditions where it is desirable to

limit the radiation reaching underlying tissues.

The authors wish to express their appreciation to Mr. J. A. Victoreen, who made available a standard air chamber for some of the work, and to Mr. John P. Kelley, who assisted in the work on depth dose.

4855 Electric Ave.
Milwaukee 14, Wis.

REFERENCES

1. BRAESTRUP, C. B. Depth dose measurements for 100-, 120-, and 135-kv. roentgen rays. *Radiology*, 1944, 42, 258-272.
2. CIPOLLARO, A. C., and MUTSCHELLER, A. Absorption of roentgen rays by the skin. *Arch. Dermat. & Syph.*, 1940, 41, 87-97.
3. DAY, F. H., and TAYLOR, L. S. Absorption of x-rays in air. *J. Research. Nat. Bur. Standards*, 1948, 40, 393-399.
4. EDDY, C. E., and FARRANT, J. L. Air absorption corrections for soft x rays. *Brit. J. Radiol.*, 1944, 17, 278-279.
5. LAMERTON, L. F. Physical investigation of the radiation from a low-voltage x-ray tube (cautery technique). *Brit. J. Radiol.*, 1940, 13, 136-146.
6. OLIVER, R., and KEMP, L. A. W. An investigation into some factors affecting x-ray dose dis-

- tribution and its measurement. *Brit. J. Radiol.*, 1949, 22, 33-43.
7. QUIMBY, EDITH H., and FOCHT, ELIZABETH F. Dosage measurements in contact roentgen therapy. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 653-668.
 8. QUIMBY, E. H., MARINELLI, L. D., and FARROW, J. H. A study of back-scatter. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 39, 799-815.
 9. SPIERS, F. W. Materials for depth dose measurement. *Brit. J. Radiol.*, 1943, 16, 90-97.
 10. TROUT, E. D., and ATLEE, Z. J. Low absorption roentgen-ray measurements from 10 to 250 kilovolts. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 47, 785-790.
 11. VICTOREEN, J. A., ATLEE, Z. J., and TROUT, E. D. The behavior of thimble chambers when used for the measurement of very soft radiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 53, 391-394.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

ROENTGENOLOGIC CONTROL OF URETERAL CALCULI ON THE OPERATING TABLE

By ERNEST NEWMAN, M.D., and LESTER NARINS, M.D.

*From the Departments of Radiology and Genito-Urinary Surgery, Beth Israel Hospital
NEW YORK, NEW YORK*

ONE of the hazards of surgery of ureteral calculi is the occasional inability of the surgeon to find the calculus or calculi after the ureter has been exposed surgically. It is known, for instance, that spinal anesthesia induces relaxation of the ureter, and occasionally after the administration of such an anesthetic, and in the movement incident to positioning, a calculus in one portion of the ureter, as determined by roentgen ray immediately prior to surgery, may shift either up or down in position, so that it cannot be found in the expected area. The portion of the ureter that can be exposed surgically is limited by the type of incision made for its approach. To make a lumbar incision, and then find that for the reasons mentioned above, the stone has slipped to the lower portion of the ureter and cannot be reached, is indeed an embarrassing situation. It was just such a case recently, in which one of two ureteral calculi was lost at the time of operation, that stimulated our interest in a method of roentgenologic control of ureteral calculi.

Prior to the fundamental work in roentgen control of calculi, done by Braasch and Carman,² the surgeon could depend only on his sense of touch to find a calculus or to determine if all the calculi present in the kidney had been removed. Quinby³ and then Beer¹ used small films enclosed in sterile coverings, and took roentgenograms of the entire kidney after surgical exposure of this organ. However, after a search of the literature, we have been unable to find a

report of a method by which the entire length of the ureter has been encompassed by a roentgen film on the operating table. The apparatus for such a film is standard and well known. The application of the method, however, is apparently new, and in suitable cases may be potentially of great value. By the method to be described, a simple abdominal film may be taken at any time during the operative procedure whether the patient is in the anteroposterior or lateral recumbent position.

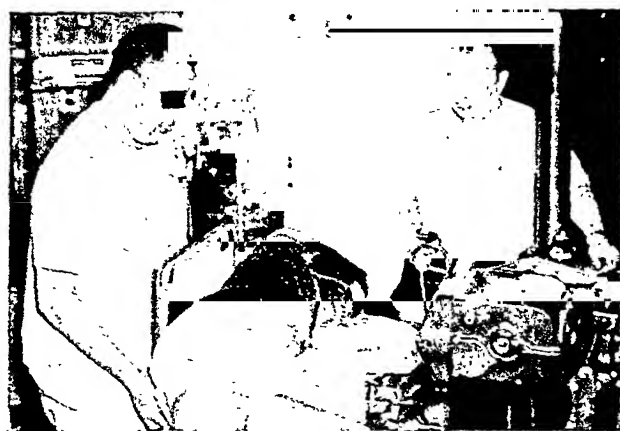


FIG. 1. This shows the technique employed when the patient is in the lateral recumbent position. The assistant holds the 14 by 17 inch cassette, in front of which is the Lysholm grid. Sterility is maintained by covering the cassette, grid, assistants' hands and forearms with a sterile sheet, thus allowing the cassette and grid to be brought close to the patient. It is important in positioning the patient that the true lateral position be attained. If this is not possible, angling of the tube is essential.

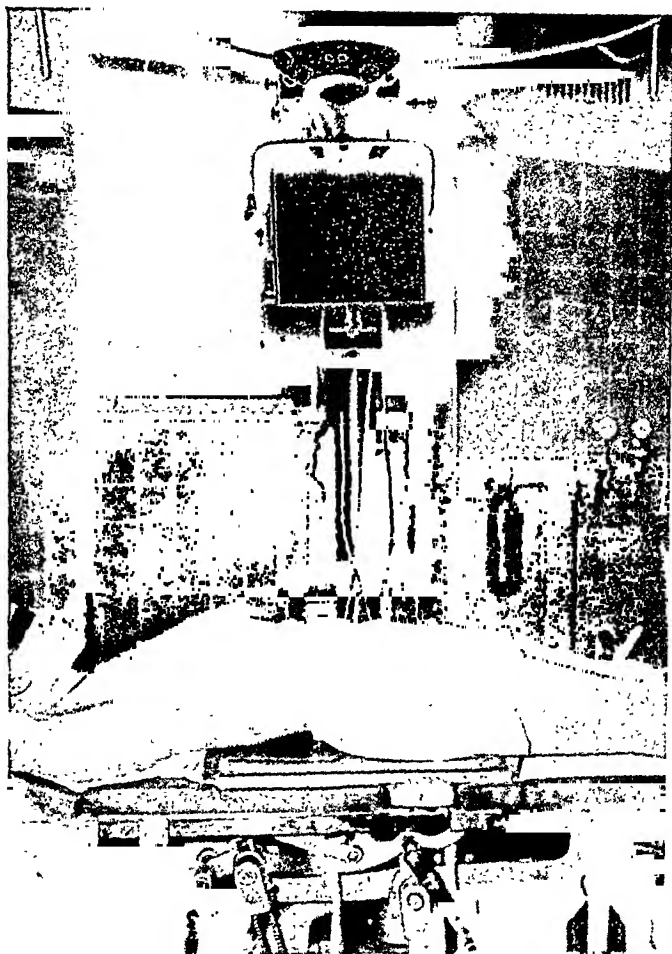


FIG. 2. The technique employed with the patient in the anteroposterior position. The wooden tunnel, loaded with the cassette and grid, is placed on the operating table prior to the operation.

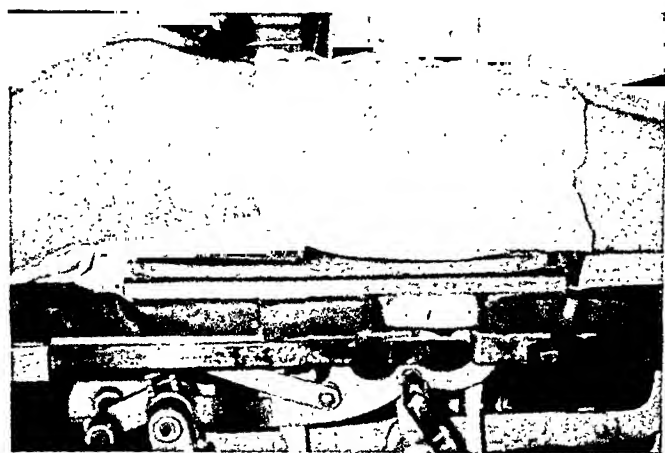


FIG. 3. A close-up of the loaded tunnel. The cassette may be exposed and exchanged during any part of the operative procedure without disturbing sterility. Films are developed and are available immediately for reading.

APPARATUS AND TECHNIQUE

The apparatus required for this method consists of a standard portable roentgen machine, a Lysholm stationary grid, and a wooden tunnel with a double slot for the grid and the cassette. The average factors used at this institution have been 25 ma.,



FIG. 4. A preoperative roentgenogram made on the operating table after the patient had been positioned anteroposteriorly, and had been anesthetized. The roentgenogram shows an opaque shadow in the region of the right lower ureter.

85 kv., and two seconds. In all cases, the preoperative exposure is taken after the anesthetic has been administered, and the patient positioned on the operating table. It is important that explosive anesthetic gases should not be used when this method is employed. Figures 1, 2, 3, 4, 5 and 6 illustrate the technique and roentgenograms obtained.



FIG. 5. A roentgenogram made immediately after ureterolithotomy. A bougie has been inserted into the ureter from above. The surgical wound is still open, and sterility has been maintained.



FIG. 6. A preoperative exposure made on the operating table after the patient had been anesthetized and placed in the lateral recumbent position. The roentgenogram shows an opaque shadow in the region of the left upper ureter.

CONCLUSION

The purpose of this presentation has been mainly to re-emphasize the value of roentgen control in surgery of ureteral calculi. In such cases when a ureteral calculus cannot be found at the time of surgery the simplicity of the method described allows for the immediate use of roentgenologic control.

165 East 71st St.
New York 21, N. Y.

REFERENCES

1. BEER, E. Roentgenological control of exposed kidneys in operations for nephrolithiasis, with use of special intensifying cassette. *J. Urol.*, 1931, 25, 159-164.
2. BRAASCH, W. F., and CARMAN, R. D. Renal fluoroscopy at the operating table. *J.A.M.A.*, 1919, 73, 1751-1752.
3. QUINBY, W. C. Note on localization of renal calculi by aid of x-ray made during operation. *Tr. Am. A. Genito-Urin. Surgeons*, 1924, 17, 199-200.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. *Foreign*

Collaborators: GÖSTA FORSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San José, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.; *Secretary:* H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio.

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fiftieth Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949.

AMERICAN RADIUM SOCIETY

President: Maurice Lenz, New York, N. Y.;
President-Elect: William S. MacComb, New York, N. Y.; *1st Vice-President:* Leland R. Cowan, Salt Lake City, Utah; *2nd Vice-President:* James A. Corscaden, New York, N. Y.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: William E. Costolow, Chairman, Los Angeles, Calif., Charles L. Martin, Dallas, Texas, A. N. Arneson, St. Louis, Mo.

Program Committee: William S. MacComb, Chairman, New York, N. Y., James F. Nolan, Los Angeles, Calif., John E. Wirth, Baltimore, Md., John V. Blady, Philadelphia, Pa.

Publication Committee: Edward H. Skinner, Chairman, Kansas City Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Research and Standardization Committee: Robert B. Taft, Chairman, Charleston, S. C., Jacob R. Freid, New York, N. Y., K. W. Stenstrom, Minneapolis, Minn.

Education and Publication Committee: James A. Corscaden, Chairman, New York, George C. Andrews, New York, A. N. Arneson, St. Louis, Mo.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: E. P. Pendergrass, Chairman, Philadelphia, Pa., John F. Hynes, Wilmington, Del., P. C. Swenson, Philadelphia, Pa.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., J. E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: 1950, to be announced.

EDITORIAL

THE ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Fiftieth Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949.

This meeting of the Society promises to be a most important and scientifically profitable one. The selection of the Netherland Plaza Hotel as a meeting place is a splendid choice since the hotel facilities, as all the members of the Society well know, are ample to house the scientific and technical exhibits, and the rooms that are available for the instruction courses are unequalled. The Society returns to Cincinnati with pleasant memories of the previous meetings in that delightful city.

The program, which has been arranged for the Fiftieth Annual Meeting by President-Elect Portmann and his Committee, is a splendid one and should make a special appeal not only to the members of the Society but to all those attending the meeting. The program, which is published elsewhere in this issue, is evidence itself of the care that has been exercised in the arrangement of the scientific section. Doctor Portmann is to be congratulated upon having secured some of the leading medical men, internists, surgeons and radiologists to participate in this splendid program.

The Caldwell Lecture this year is to be held on Wednesday evening, October 5, and Doctor Portmann has selected Doctor Stanley P. Reimann, Director of the Research Institute, Lankenau Hospital, Philadelphia, Pennsylvania, to give the address. Doctor Reimann has chosen for his subject "The Differentiation of Cells and Tissues." This topic, needless to say, is of great impor-

tance to the medical profession and Doctor Portmann has made a happy choice in the selection of Doctor Reimann to give this important annual lecture.

The Instruction Courses this year are again under the directorship of Doctor Harry M. Weber. These courses, as always, are an important feature of the annual meetings, and the comprehensive courses which have been arranged by Doctor Weber are set forth elsewhere in this issue of the JOURNAL. Since the number who may attend these courses is of necessity limited, it is urged that those who anticipate taking such courses will fill out the order blanks at once in order to avoid any last minute confusion at the time of the meeting.

The Chairman of the Scientific Exhibit Committee is Doctor C. A. Good. He and his Committee have also arranged a superb exhibit covering many scientific problems of interest to radiologists, and some of the exhibits amplify and extend the papers that are to be given in the Scientific Program.

The Commercial Exhibit, which is one of the most important features of the annual meeting, is this year the largest that the Society has ever had, and the extent and scope of these exhibits should prove of greatest interest and profit to those attending the meeting. Fortunately, Doctor Portmann and his Program Committee have allotted a sufficient time during the morning and afternoon for viewing the Scientific and Commercial Exhibits.

The social functions of the meeting have not been neglected. The annual Golf Tournament for the Willis F. Manges Trophy will be held on Monday, October 3, at the

Kenwood Country Club. The annual banquet with well chosen entertainment will be held on Thursday evening; and the Ladies Entertainment Committee has arranged an excellent and varied program for the visiting ladies.

Thus, the forthcoming meeting in Cin-

cinnati should stimulate much interest and will, undoubtedly, attract a large number of radiologists. In view of this, it is urged that all who anticipate attending the meeting make their reservations with the Netherland Plaza Hotel at the earliest possible moment.





ALFRED ERNEST BARCLAY

O.B.E., M.D. (Camb.), D.M. (Oxon.), D.Sc. (Hon. Oxon., and Manchester)
F.R.C.P., D.M.R.E., F.F.R.

1877-1949

DR. A. E. BARCLAY, "Barclay of Manchester," as he was known to a host of friends throughout the world, died at his home at Oxford, England, on April 26, 1949, at the age of seventy-two. His life was a long and useful one in the practice of medicine and radiology. He could look back over his shoulder at fifty years in which he

spent his life in and for radiology, though he was the sort of individual who rarely looked over his shoulder to the years, that had passed, but his thoughts were ever of the present and of the future of medicine and radiology and what part he might play in that field of endeavor to further extend knowledge into the realm of the unknown, and he bent his efforts toward solving some of the difficult problems in medicine and biology.

Alfred Ernest Barclay was born in Manchester, England, the son of Robert Barclay, on September 30, 1876, and was educated at Leys School and at Christ's College, Cambridge, and for his clinical studies he went to London, to the London Hospital, where after qualifying in 1904, he held various house appointments, and in his student days he became interested in radiology. While still at the London Hospital he became Accident Room Officer, and it was in this capacity while screening for innumerable needles and other foreign bodies that he began to appreciate the possibilities of roentgenologic investigation.

His first appointment as radiologist was as Clinical Assistant to Dr. Morton of the Electro-Medical Department and Clinical Assistant also to Dr. Sequeira of the Skin Department where treatment of ring worm was the main activity.

In 1906, having served such apprenticeship as was possible in those days of radiology at the London Hospital he went back to his native city of Manchester and in partnership with Dr. Bythell he set up in the private practice of radiology "to face the competition of a firm of chemists who had all of the x-ray work of the city." Following closely upon the heels of the opening of his office at Manchester he became Honorary Radiologist to the Ancoats Hospital and in 1909 he was appointed to organize an X-ray and Electrical Department in the new Manchester Royal Infirmary. There in the basement of that Infirmary with the crudest of apparatus he began his studies on the gastrointestinal tract. At the beginning of these studies he realized that it was

the living anatomy that was of importance to the radiologist and that the "'dead' anatomy as was taught in the medical schools was wrong from every point of view." In his appreciation of the living anatomy as revealed in the roentgen studies, he began a campaign which he waged throughout his long life for a better knowledge and understanding of the normal structures as revealed by roentgenology, both from the anatomical and physiological viewpoints.

From his studies of the gastrointestinal tract he published a small monograph in association with Bythell on "X-ray Diagnosis and Treatment." This was published by the Oxford University Press in 1912. This small monograph attracted world wide attention and at once Barclay found himself among the forefront of those radiologists who were concentrating their energy and their ability in the roentgenological study of gastrointestinal problems. He was a great advocate of screen examinations of the gastrointestinal tract.

During World War I from 1914 to 1918 Barclay was commissioned as a Captain in the Royal Army Medical Corps and, with one colleague to assist him, was responsible for the x-ray service of a hospital unit which eventually grew to 35,000 beds. The supply of x-ray plates (glass plates were used in those days as negatives) was limited, consequently roentgenological work in the hospital unit consisted principally of screen localizations of foreign bodies and fractures.

Barclay tells how in those hectic days even with the press of work he found time to make a "bullet extractor, dental forceps with extractor prongs at right angles and a screen, unprotected, attached. The prongs were insulated and on meeting the foreign body they formed contact and rang a bell." In Barclay's hands it functioned well in recent cases but in long standing cases with the surrounding fibrous tissue the dissecting prongs were not strong enough for twisting and tearing fibrous tissue. In a letter to a friend he tells how he went across to France with this apparatus and demonstrated it,

but the cases were old long standing cases and the demonstrations he gave were far from convincing. This was a good thing, Barclay says, for the dangers from that type of tool were far from imaginary and hence it was not generally employed. He did, however, use the instrument at his own hospital and he recalled the use of it in the dramatic extraction of a small fragment of shell case from the lateral sinus of the brain.

Barclay was a prodigious worker in those days and he recalls how he ran the whole of the x-ray service of the Manchester Royal Infirmary single handed with the morning help of a technician and in the afternoon he carried on his private practice. Following which, he says, he was usually at committee meetings for the Red Cross for he was Assistant County Director, and in his small section of Manchester he organized twelve hospitals which gave bed accommodation and service for over a thousand patients. His inspections of these hospitals were mostly, as he said, "in the night watches when, with a swagger cane, he poked in the waste bins to check wastefulness."

Toward the end of the First World War he went to London for meetings and consultations to see what might be done to raise the status of radiology which in the Army was very low and with standards that gave tragic results clinically.

Seeing the need at first hand of better trained radiologists in those difficult days, in 1916, he thought that he might influence a Trust to endow a professorship and found an institute of radiology and he quite naturally turned to his old school, Cambridge, to survey the ground and receive encouragement for such an undertaking. But the hoped for finances did not mature. In all this endeavor he received the strong collaboration of such outstanding radiologists as Robert Knox, Sidney Russ, Cumberbatch, and others.

Barclay was not the sort of individual to be discouraged by one rebuff and in 1917 with some of his friends he persuaded the Cambridge authorities to start a course for a radiological diploma. He tells us that all

these negotiations went well but very slowly. The University (Cambridge) was a little hesitant about starting such a course but with Barclay's personal check handed over to the University to guarantee it against loss the negotiations for such a school for a radiological diploma came to fruition in 1920 when the first course opened. Barclay's enthusiasm for the course, bolstered by his friends and lecturers who worked without reward, made the course a popular one and no University funds were needed to carry on the courses.

The Manchester Royal Infirmary in 1918, recognizing the tremendous value of Barclay's work and the increasing status of radiology in the medical world, appointed him to the Honorary Staff. This was a long step in the advancement of radiology and particularly the advancement of Barclay himself for not only could he enter into the clinical life of the hospital with the full responsibilities that that implied and which he so ardently sought but in addition he had the backing of his colleagues and of the lay board in working for a new and more adequate department. This was realized in 1921 and shortly afterwards Barclay was joined on the staff at the Manchester Royal Infirmary by Dr. G. M. Woodburn Morrison.

It was during his years in Manchester that Barclay gained world wide recognition not only by his contribution to the medical literature dealing with radiological problems but by his ceaseless endeavor for the advancement of radiology in particular and medicine in general. He not only gained a world wide audience in the publication of his papers but his engaging personality and his capacity for friendships brought him a host of personal friends throughout the world.

In 1928 Barclay, at the height of his splendid position and professional standing in his native city of Manchester, decided to go to Cambridge to carry on the radiological teaching for the D.M.R.E. The altruistic spirit which Barclay exhibited in this decision was an example of the fine atti-

tudes which he displayed throughout his long professional life. Manchester was his home; here he had established his professional reputation but his great interest in the diploma course was something to which he had given much thought and with the death a year earlier of Shillington Scales the diploma course was in danger of lapsing. This decided Barclay. Cambridge University could offer little salary and, as Barclay says, not a penny for the running of the department, and for secretarial assistance and other expenses Barclay paid out of his own pocket, but the opportunities for research which such an association presented overcame these "minor" financial responsibilities. He began at once to build up techniques of examination, particularly direct cineroentgenography. It was an attempt to study the mechanism of swallowing that led to Barclay's great desire to develop this type of technique. It was Barclay's desire and intent to establish at Cambridge a well equipped radiological department functioning not only as a department of radiology but serving the biological laboratories as well. But the authorities at Cambridge saw no need for such a department and were not prepared to support the brilliant plans that Barclay envisaged. However for nine years he worked diligently building high the prestige of the Cambridge Diploma. In 1937 Cambridge University decided to abolish all diplomas and there was no place therefore for Barclay or his department in Cambridge.

At this time Janker of Bonn and Russell Reynolds were showing good results with indirect cineroentgenography. These results were shown in Oxford and half the newly acquired funds for the Nuffield Institute for Medical Research were allotted to explore this technique and Barclay was invited to join Dr. K. J. Franklin in this work which was his conception.

It was at Oxford University in the Nuffield Institute for Medical Research that Barclay's bent for mechanical gadgeteering was given full sway. He found that the apparatus which Janker and Russell Rey-

nolds had elaborated was only capable of operating vertically and hence was useless for animal work. He soon constructed a horizontal couch and a mechanism for taking direct serial roentgenograms. With this improved but inadequate setup Barclay and his coworkers did their experiments on the mechanism of dust excretion from the lungs. It was while working on this problem that Sir Joseph Barcroft asked for cooperation in his problem of what happened to the ductus arteriosus at birth and Barclay tells us "that we had a couple of years of delightful cooperation with him. The work was done on sheep fetuses. It was number 300 odd on which we started for Barcroft had been on the problem for years." For this particular type of work Barclay and his collaborators developed special techniques and by extraordinary luck at last got the direct cineroentgenographic machine to work satisfactorily. "We solved Barcroft's problem out of hand as soon as we learned to interpret the exceedingly complex shadows given by the thorotrast as it canalized the heart and main vessels. We settled the problems of the ductus as to how and when it closed and in doing so we, quite incidentally, obtained incontrovertible proof of the working of the foetal circulation as a whole and the changes that occur when adult circulation is established—a 300 year old controversy!" This work was published in 1944 in book form.

The latter part of this work was carried on during the imminence of war and Barclay in his official capacity as Adviser in Radiology to the Ministry of Health was responsible for the organization of the whole civilian x-ray service of the country and in such a capacity there was little time for research. With the rapid expansion of the hospital facilities to care for the wounded and sick it became Barclay's responsibility to see that each of these hospitals had properly equipped departments with such equipment as was available in those hectic days, and not only must these departments be equipped but supervised by a much reduced number of radiologists.

This however was accomplished with Barclay's usual thoroughness, and considering the conditions, the standards of roentgen-ray services were surprisingly high. In his capacity as Adviser to the Ministry of Health, Barclay travelled the whole country from end to end visiting all these hospitals and seeing all the radiologists in their home working conditions. He found it extremely interesting and quite invaluable work but it must have made great inroads upon his own physical well being, though he never admitted it.

It was in 1940 that Trueta and Barnes came to discuss with him the problem of uremia following traumatic crushed limbs. But while there was much discussion concerning the problem and it offered an intriguing type of investigation as well as an interesting one, the press of war and the conditions which it posed prevented any serious approach to the problem until 1945. As soon as the war was over, they started work on this problem. They were in possession at this time of a well equipped department at the Nuffield Institute and it was easy to adapt the techniques that had been employed for the fetal circulation work, and again roentgenology was the spearhead of attacking the problem and direct cine-roentgenography was the key technique which gave exact timing of the flow. Barclay says, "The story of this, the most exciting and satisfying research in which I have ever taken part, is told in the book of renal studies in which we brought forward the conception of the peripheral vascular supply as virtually an organic structure spread through the kidney, and likely spread throughout the whole body on much the same plan, to regulate the supply of blood to organs on a functional basis. In the later stages of this work the work passed out of the range of radiology into histology. Could radiology help in this as in other branches?" Barclay tells us he set to work on this problem and within a few weeks demonstrated to his own satisfaction that given suitable equipment "I would be able to show even capillaries on radiographs.

Moreover I would not only be showing them as under a microscope but in a big field in which capillaries and other vessels would be seen over considerable lengths and we should get some sense of the relationship of small vessels to large vessels." And out of this work came his important paper "Micro-arteriography."*

Barclay, as ever intrigued with interesting problems of research and their possibilities, thought of the important "side line" that has evolved out of this technique in the incursion into the field of botany and he published his interesting observation from this study in the *British Journal of Radiology*.

Following a major operation two years ago Barclay realized that he was perhaps living on borrowed time and with characteristic courage in spite of his lessening energies he drove himself with added interest into his work on microradiography and in conjunction with F. H. Bentley there resulted the discovery of a circulatory shunt mechanism in the wall of the stomach,† thus proving his belief that the "peripheral vascular supply which he observed in his studies on the kidney was most likely spread throughout the whole body on much the same plan to regulate the supply of blood to organs on a functional basis." Thus, among the last of Barclay's observations was a magnificent piece of research carried on by a man whose days and length of life were numbered.

In the winter of 1948 he went to Torquay but realizing as he did the short space of time remaining for him, he took his laboratory with him and erected it in a "back bedroom only 20 yards from his own bedroom." He says it was a "delightful little laboratory and well equipped and more convenient than what I have in Oxford." But his strength was far spent and he says he could do nothing even under those easy conditions. "Luckily," says he, "I had an A-1

* *Brit. J. Radiol.*, 1947, 20, 394-404; *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 69, 1-12.

† See Editorial, "Gastric vascular shunts." *AM. J. ROENTGENOL. & RAD. THERAPY*, April, 1949, 61, 561-564.

laboratory assistant who did things for me and I did get some bit of result that made the whole move well worth while." He found that even with such an outfit as he had established in his back bedroom he was able to show the nuclei of cells.

His last paper dealing with the occurrence of hematite deposits was published in the May, 1949, issue of the *British Journal of Radiology*. In a letter written on April 1, 1949, he says apropos of this work, in spite of his enfeebled condition, of which he complains bitterly: "Yet only 2 days ago I did a trick and sent a page to the B.J.R.—a lucky last fluke of an exposure I did at Torquay. It shows iron absorbed into and around the nuclei of the lung cells in a haematite miner—it was the only specimen I happened to have at Torquay—if I'd used normal tissue I'd have drawn a blank, as my assistants did when they tried to repeat when the apparatus was reinstalled here [at Oxford]. So luck holds right up to the end. And what a lot of fun I've had out of 50 years in radiology!"

In these last days Barclay saw his greatest triumph for in these few months he made epoch-making contributions to physiology as well as to pathology by the use of roentgenological methods, and one recalls a statement which he made in a recent letter: "... discoveries lie all round for any man who has the sense and adaptability to take radiology into physiological, pharmacological, zoological and botanical research." One of America's greatest physiologists in commenting on Barclay's studies in which he employed microradiography says that he thinks "the technique is one of the greatest milestones in medical science."

Barclay was in turn President of the Röntgen Society, of the British Institute of Radiology, and of the Electrotherapeutics Section of the Royal Society of Medicine. In 1931 he was appointed Silvanus Thompson lecturer. He had been chosen to deliver the Mackenzie Davidson Memorial Lecture under the auspices of the British Institute of Radiology in March, 1949, but when the time came he was far too ill to do so, and

the Institute as a mark of respect to him met only for formal business, arranging no other event to take the place of the expected lecture. Its president travelled to Oxford to present him with the lecturer's medal. Barclay was an honorary member of the American Roentgen Ray Society and of the Australian and New Zealand Association of Radiology, and an honorary fellow of the American College of Radiology; he was a corresponding member of the Radiological Society of North America.

Barclay was the author of innumerable articles published in scientific journals throughout the world and the author and co-author of several books. In addition to his first radiological publication "X-ray Diagnosis and Treatment" published in 1912 in collaboration with Bythell, his textbook on the "Digestive Tract" appeared in 1933 and there was a second edition published in 1936. His studies with Trueta on the renal circulation were fully published in book form in 1947.

In 1906 Dr. Barclay married Miss Mary McFarlane and what a happy choice he made! Barclay himself attributed what success he might have had to the help and ability of Mrs. Barclay who looked after everything in his life outside of his medical specialty, thus leaving him free to direct his creative faculties, and those who have been privileged to visit the Barclays' home will recall pleasant memories of a charming host and hostess.

Barclay was the recipient of many honors and gave many memorial and other lectures both in England and abroad. Among his latest honors and perhaps the ones he valued most were the awards of the Honorary D.Sc. by both Oxford and Manchester Universities. In March, 1949, Barclay received the Bose Memorial Gold Medal as the first Lecturer (in absentia) in memory of the outstanding Indian scientist Sir Jagadish Bose. He was at the time of his death President Emeritus of the Sixth International Congress of Radiology which is to be held in London in 1950 and he had a unique record of an unbroken attendance at all of the

past five International Congresses of Radiology. Barclay will be sorely missed at the forthcoming meeting in his own country.

He has a host of friends and acquaintances throughout the world who mourn his death. During his long life, in spite of the great honors that came to him and the magnificent work which he had done, he never lost the common touch and he made friends and inspired individuals wherever he went and it was a fitting tribute to a worthwhile life that prompted Oxford and Manchester Universities to confer upon him one of their most coveted gifts. Their stamp of approval in conferring such an honor was a just tribute to one whom the medical world has known over the years as being one of the "greats" in medicine. His

friends and admirers were just as numerous in this country as in his own native England and one might paraphrase the oft repeated statement that "there will always be an England" by saying that "there will always be a medical England as long as it produces men of the stamp of Barclay." He stands with Hunter, Bright, Hodgkin and a whole host of others in England who have always attracted the medical minds of the world.

Barclay's indomitable spirit and search for knowledge carried him through years which would have daunted men of lesser soul and by such an example he sets a challenge to us elders and an inspiration to the youth of the world.

L.R.





HENRY HULST
1859-1949

THE death of Dr. Henry Hulst in Grand Rapids, Michigan, on January 2, 1949, writes finis to one of the most noteworthy careers in radiology. The roentgen diagnosis of tuberculosis probably owes more of its foundation to Henry Hulst than to any other American radiologist, in that he was the first to roentgenograph the chest in one

second or less; and this without the relatively unsatisfactory intensifying screens of 1903. Older radiologists will remember that M. K. Kassabian of Philadelphia was an able pioneer, a martyr to the deadly quality of the unknown for which the "x" still stood in "x-ray." In December, 1903, at the Philadelphia meeting of the American Roent-

gen Ray Society, Dr. Kassabian showed, and later published, a roentgenogram of a chest showing large tuberculous cavities, made in three installments of ten seconds each, while the patient held his breath, and breathed between times. This was a great improvement on the then standard plates (for roentgenograms were on glass plates until the demands of the First World War were met with films) made while the patient breathed. At this same meeting, Dr. Hulst showed plates made in a second or less, of a diagnostic quality that would pass today. (He showed them in Chicago in 1902!) The Transactions of the American Roentgen Ray Society (1904) show a normal chest and a tuberculous chest. Dr. Hulst attained these short exposures by substituting for the interruptor-coil a static machine made to his specifications, with 50 shellac and mica plates 28 inches in diameter, and 50 stationary glass plates 32 inches in diameter, a machine tested to perform at 7,000 r.p.m., but functioning at 1,800. His achievement was honored by the presidency of the American Roentgen Ray Society for 1905 and 1906.

This reporter has urged Mrs. Hulst, whose copper-plate handwriting betrays no inroads of age on either hand or brain, to write the history of Dr. Hulst and his times; it would be a precious source-book of one of the most productive periods in science. She replied, "I should like to do it, but feel incompetent to do it—I am too near. I have been thinking that you will want to know that Doctor Hulst said of his own work that he had always been a playboy and had never worked on medicine or the x-ray—and I think that is correct. He was not a plodder, and took endless pains because he was so interested."

From Mrs. Hulst, from Dr. Henry Duiker of Grand Rapids, and from the early publications of this Society, it is learned that Dr. Hulst was born in The Netherlands, in the province of Friesland, on June 25, 1859. He came to America in 1874, when his father, the Reverend L. J. Hulst, accepted a call to the church in

Danforth, Illinois. He received his A.B. from Hope College, in Holland, Michigan; then, following in his father's footsteps, he entered the study of theology at Princeton. However, he soon realized that he desired more to be a physician, and the following year he entered the medical school of the University of Michigan, and received his M.D. in 1888.

Mrs. Hulst tells us, "He began his medical practice as an assistant physician at the State Asylum for the Insane in Traverse City, where he became interested in hypnosis as a therapeutic agent, and after visiting clinics in Amsterdam and Paris he applied it in his practice and wrote several notable papers on the subject." (E.g., "Gastrostomy in Hypnosis" *Medical Record*, 1897, 51, 43.) Dr. Duiker states that "When patients began to ask to be hypnotized over the telephone, he decided that his notoriety in hypnotism would prevent his practicing medicine ethically, so he dropped the practice in hypnosis and became interested in x-ray."

Dr. Lewis Gregory Cole, who pays eloquent tribute in "Lung Dust Lesions Versus Tuberculosis" to Dr. Hulst's pioneer work in roentgen diagnosis of the chest, speaks on page 311 of that volume of asking a pathologist, a personal friend, for some lungs, and being told "You can't have those lungs. X-ray is only a *black art*, and anyone who has anything to do with it is a *charlatan*. For the sake of our family acquaintance I won't let you do this, and furthermore, I shall do anything I can to prevent you from getting them elsewhere." Dr. Hulst's work—or as he preferred to regard it, play—with roentgen rays advanced radiology so abundantly that it interests this writer to muse on whether, had Dr. Hulst stayed with hypnotism, so obviously useful a psychiatric tool would have gone as far into eclipse as it has.

The historian of the American Roentgen Ray Society has had close professional association with Dr. John R. Carty, Dr. Raymond W. Lewis, and Dr. William Snow, all three of whom have written ably on soft

tissue roentgenography; and he had gotten the idea that soft tissue roentgenography was rather a recent refinement. He finds that Dr. Hulst read a paper before the International Congress of Radiology in Amsterdam, published in the *New York Medical Journal* for January 22, 1908, volume 88, page 1224, under the title "Soft Tissue Roentgenography." He discusses contrast versus detail; and how does this sound for 1909? "The first period of roentgenology, the period of screaming contrasts, passes over into that of detail in soft tissues."

In 1913 and 1914, your reporter can testify first-hand, professors of anatomy were still holding students to know under which left ribs fore and aft the stomach was located. In 1905 Dr. Hulst reported, "A cursory examination of the 22 cases described discloses the fact that the x-ray picture of the normal stomach and colon, semidistended with milk and bismuth, is not what our text-books of anatomy would lead us to expect. . . . If the text-books are correct I have not yet succeeded in finding a normal stomach. Extended x-ray observations will probably change the current conception of this organ."

Dr. Hulst was thirty-six and a half years old when Röntgen discovered the x-ray. He was only fifty-four years old when severe diabetes forced his retirement from practice. His place among radiology's immortals was earned before 1914. A Grand Rapids colleague comments, "His situation is peculiar in that he has so long outlived his contact with his specialty. For that reason

few of the radiologists in this area knew him or had even met him." Self-preservation turned his attention to diabetes, and in the words of Dr. Duiker, "insulin gave him a new lease on life. He began making exhaustive studies of diabetes on himself, making thousands of blood sugar readings and keeping detailed notes of all his findings. In spite of his severe diabetes, he lived to be nearly 90 and he died of arteriosclerosis, which led to a cerebral thrombosis." Although he was very early in radiology, and consequently incurred no little damage to his hands, he lost no fingers. This relatively good fortune may well be due to his early development of short exposures, at a time when his contemporaries were observing the tube with their hands as a test-object, during the course of long ones.

Dr. Duiker remarks, "Dr. Hulst had a scientific and a camera mind, and remembered when and where and on what page things were written. His knowledge of philosophy and theology was amazing. He kept up with newer developments in medicine, economics, art, and a variety of subjects. Mrs. Hulst also was well read and very intellectual. She is almost ninety years of age and very alert mentally. An evening spent with Dr. and Mrs. Hulst was a truly stimulating experience."

The American Roentgen Ray Society pays its tribute to one of the truly great builders of the foundation of radiology; and to the rare spirit who survives him "after fifty-nine years of rare companionship."

RAMSAY SPILLMAN, M.D.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4-7, 1949.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1950, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. Joseph Daversa, 603 Fourth Ave., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at

Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Lochr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Boyd Isenhart, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W. 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. I. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Andreilino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martín-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloristr. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

PRELIMINARY PROGRAM

FIFTIETH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Fiftieth Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on October 4, 5, 6, and 7, 1949.

The Executive Council will meet at noon on Sunday, October 2.

The annual Golf Tournament for the Willis F. Manges Trophy will be held on Monday, October 3, at the Kenwood Country Club.

The Caldwell Lecture will be given on Wednesday evening, October 5, and the Annual Banquet will be held on Thursday evening, October 6.

The Instruction Courses will begin at 8:30 A.M., each day of the meeting, and elsewhere in this issue will be found the detailed plan of the courses.

The Scientific Program has been arranged as follows:

Tuesday, October 4, 1949

8:30 A.M. Instruction Courses.

10:00 A.M. Study of Scientific and Commercial Exhibits.

11:00 A.M. Call to Order, Fiftieth Annual Meeting, Lawrence Reynolds, M.D., President.

Presentation of Scientific Awards by the President.

Installation of the President-Elect, U. V. Portmann, M.D., Cleveland, Ohio, by President Reynolds and the Chairman of the Executive Council, Hugh F. Hare, M.D., Boston, Mass.

Address of Welcome: Raymond Walter, President of the University of Cincinnati.

Inaugural Address: President U. V. Portmann, M.D.

Paper
No.

1. Study of Human Arteries by Different Radiographic Methods. Otto Glasser, Ph.D., Cleveland, Ohio.

2:00 P.M.

2. The Value of Tannic Acid and Post-

evacuation Films. Arthur C. Christie, M.D., Fred O. Coe, M.D., Aubrey O. Hampton, M.D., and George M. Wyatt, M.D., Washington, D.C.

Discussion by Harry M. Weber, M.D., Rochester, Minn.

3. An Aid to the Diagnosis of Polypoid Lesions of the Colon. Robert M. Potter, M.D., Chicago, Ill. (by invitation). Discussion by Paul C. Swenson, M.D., Philadelphia, Pa.

4. A Study of End-to-End Anastomosis of the Colon following Colonic Resection. Meyer Sharpe, M.D. (by invitation) and Ross Golden, M.D., New York, N.Y.

Discussion by James T. Case, M.D., Chicago, Ill.

5. Gastrointestinal Radiographic Observations of Patients treated by Vagotomy. C. A. Priviteri, M.D., Chamblee, Ga. (by invitation).

Discussion by Ross Golden, M.D., New York, N.Y.

6. Renal Cysts. Harold C. Ochsner, M.D., Indianapolis, Ind.

Discussion by H. Dabney Kerr, M.D., Iowa City, Ia.

4:30 P.M. Executive Business Session of the Society.

Wednesday, October 5, 1949

8:30 A.M. Instruction Courses.

10:00 A.M. Study of Scientific and Commercial Exhibits.

11:00 A.M.

7. Traumatic Diaphragmatic Hernia. B. Noland Carter, M.D., and Jerome Giuseffi, M.D., Cincinnati, Ohio (both by invitation).

Discussion by Charles M. Barrett, M.D., Cincinnati, Ohio (by invitation).

8. An Epidemic of Acute Granulomatous Pneumonitis. Benjamin Felson, M.D., George F. Jones, M.D., and Robert P. Ulrich, M.D., Cincinnati, Ohio (all by invitation).

Discussion by Albert B. Sabin, M.D., Cincinnati, Ohio.

9. Pulmonary Calcifications—Tuberculo-

sis? Histoplasmosis? Frederic N. Silverman, M.D., Cincinnati, Ohio (by invitation).

Discussion by W. Edward Chamberlain, M.D., Philadelphia, Pa.

2:00 P.M.

10. Alveolar Cell Tumors of the Lung. C. Allen Good, M.D., J. R. McDonald, M.D. (by invitation), and O. T. Claggett, M.D. (by invitation), Rochester, Minn.

Discussion by Donald B. Effler, M.D., Cleveland, Ohio (by invitation).

11. Mediastinal Emphysema. John A. Evans, M.D., and Ted R. Smalldon, M.D., New York, N.Y. (both by invitation).

Discussion by Leo G. Rigler, M.D., Minneapolis, Minn.

12. Unusual Lesions Involving the Vertebrae and Intervertebral Discs in Children. Eugene L. Saenger, M.D., Cincinnati, Ohio (by invitation).

Discussion by Ralph S. Bromer, M.D., Bryn Mawr, Pa.

13. Poisoning Due to Ingestion of Excess Vitamin A. John Caffey, M.D., New York, N.Y.

Discussion by Merrill C. Sosman, M.D., Boston, Mass.

14. Osseous and Articular Complications of Hypervitaminosis D. William R. Christensen, M.D., Charles Liebman, M.D. (both by invitation), and Merrill C. Sosman, M.D., Boston, Mass.

Discussion by John Caffey, M.D., New York, N.Y.

Wednesday Evening, October 5, 1949

Eight-Thirty O'Clock

The Caldwell Lecture

Stanley P. Reimann, M.D.

Director of the Research Institute, Lankenau Hospital, Philadelphia, Pennsylvania;

"The Differentiation of Cells and Tissues"

Introduction—Bernard P. Widmann, M.D., Philadelphia, Pennsylvania.

Thursday, October 6, 1949

8:30 A.M. Instruction Courses.

10:00 A.M. Study of Scientific and Commercial Exhibits.

11:00 A.M.

Symposium: Application of Radioactive

Isotopes. Arranged by Western Reserve University, School of Medicine, Cleveland, Ohio.

15. Description of a Sr^{90} Beta Ray Applicator and Its Use on the Eye. Hymer L. Friedell, M.D., Charles I. Thomas, M.D., and Jack S. Krohmer, B.S., Cleveland, Ohio (all by invitation).

Discussion by Roscoe J. Kennedy, M.D., Cleveland, Ohio (by invitation).

16. Use of Radioactive Phosphorus in the Treatment of Carcinoma of the Breast with Widespread Metastases to Bone. Hymer L. Friedell, M.D., and John P. Storaasli, M.D., Cleveland, Ohio (both by invitation).

Discussion by T. Leucutia, M.D., Detroit, Mich.

17. I^{131} in the Diagnosis and Treatment of Hyperthyroidism. R. A. Shipley, M.D., John P. Storaasli, M.D., Hymer L. Friedell, M.D., and Albert Potts, M.D., Cleveland, Ohio (all by invitation).

Discussion by U. V. Portmann, M.D., Cleveland, Ohio.

2:00 P.M.

18. Clinical Isodose Curves. B. S. Wolf, M.D., and R. Loevinger, Ph.D., New York, N.Y. (both by invitation).

Discussion by William Harris, M.D., New York, N.Y.

19. Design Characteristics for Standard Ionization Chambers up to 500 kv. From the National Bureau of Standards. R. J. Kennedy, Ph.D., and W. Snyder, B.S., Washington, D.C. (both by invitation).

Discussion by Lauriston S. Taylor, Ph.D., Washington, D.C.

20. Biological Effects of High Energy Roentgen Rays. Henry Quastler, M.D., Urbana, Ill. (by invitation).

Discussion by Kenneth E. Corrigan, Ph.D., Detroit, Mich.

21. Carcinoma of the Cervix Given Roentgen and Fractionated Radium Therapy Concurrently. Howard B. Hunt, M.D., and Robert M. Coleman, M.D., (by invitation), Omaha, Neb.

Discussion by Ralph M. Caulk, M.D., Washington, D.C.

22. Urethane in the Treatment of Multiple Myeloma. R. Wayne Rundles, M.D.

(by invitation) and Robert J. Reeves, M.D., Durham, N.C.

Discussion by T. Leucutia, M.D., Detroit, Mich.

4:30 P.M. Executive Business Session of the Society.

Thursday Evening, October 6, 1949

Seven-Thirty O'Clock
Annual Banquet

Friday, October 7, 1949

8:30 A.M. Instruction Courses.

10:00 A.M. Study of Scientific and Commercial Exhibits.

11:00 A.M.

Symposium: Combined Management of Hematologic and Allied Diseases from the Medical and Radiologic Viewpoints.

Arranged by Ohio State University, College of Medicine, Columbus, Ohio.

23. Leukemia, Polycythemia and Related Diseases. Claude-Starr Wright, M.D., Columbus, Ohio (by invitation).

Discussion by William E. Howes, M.D., Brooklyn, N.Y.

24. Hodgkin's Disease and Allied Disorders. Herman Hoster, M.D., Columbus, Ohio (by invitation).

Discussion by Maurice Lenz, M.D., New York, N.Y.

25. Diagnosis and Treatment of Lymphoblastoma and Leukemia from the Standpoint of the Radiologist. Joseph

L. Morton, M.D., Columbus, Ohio (by invitation).

Discussion by Harold W. Jacox, M.D., New York, N.Y.

2:00 P.M.

26. Clinical and Technical Problems in Angiography. Russell H. Morgan, M.D., Baltimore, Md.

Discussion by Wendell G. Scott, M.D., St. Louis, Mo.

27. Coronary Angiography. James A. Helmsworth, M.D., Johnson McGuire, M.D., and Benjamin Felson, M.D., Columbus, Ohio (all by invitation).

Discussion by J. Harold Katte, M.D., Columbus, Ohio (by invitation).

28. Angiographic Studies of the Pulmonary Artery. Joseph E. Miller, M.D., Dallas, Texas (by invitation).

Discussion by Fred J. Hodges, M.D., Ann Arbor, Mich.

29. The Angiocardiographic Diagnosis of Operability in Lung Cancer. Charles T. Dotter, M.D., Israel Steinberg, M.D., and Cranston W. Holman, M.D., New York, N.Y. (all by invitation).

Discussion by LeRoy Sante, M.D., St. Louis, Mo.

30. Cerebral Arteriography. C. Robert Hughes, M.D., Robert E. Wise, M.D., and John R. Hannan, M.D., Cleveland, Ohio (all by invitation).

Discussion by W. James Gardner, Cleveland, Ohio (by invitation).



AMERICAN ROENTGEN RAY SOCIETY

SECTION ON INSTRUCTION

HARRY M. WEBER, M.D., *Director*

Titles and Abstracts of Courses Offered

Fiftieth Annual Meeting

Netherland Plaza Hotel, Cincinnati, Ohio

October 4-7, 1949

PRESIDENT-ELECT Portmann, with the approval of the Executive Council, has directed that the Section on Instruction be continued for the annual meeting of 1949. His program has been arranged so that the Instruction Courses will be offered between the hours of 8:30 A.M. and 10:00 A.M. on Tuesday, Wednesday, Thursday and Friday. This year only one course will be offered in each of the eleven rooms assigned for this purpose. Thus a total of 90 minutes has been made available for each course which makes it possible for instructors to devote more time to discussion and to conference with those attending the course. No other official activity has been scheduled for this time.

The Section on Instruction presents for 1949:

1. A Symposium on Radioactive Isotopes (Courses 101, 102, 103), with a faculty of three instructors and covering three periods.

2. Two Special Courses, one on the Preparation and Presentation of Medical Papers (Course S-1), and one on Radiation Dosimetry (Course S-2), with a faculty of two instructors and covering two periods.

3. Three Sequential Courses, two in Diagnostic Roentgenology (Courses B and C), and one in Therapeutic Radiology (Course A), with a faculty of three instructors and covering six periods.

4. Twelve single period courses in Therapeutic Radiology (Courses 201-212), with a faculty of twelve instructors and covering twelve periods.

5. Twenty-one single period courses in Diagnostic Roentgenology (Courses 301-321), with a faculty of sixteen instructors and covering twenty-one periods.

GENERAL INFORMATION

The Faculty

Vincent W. Archer, M.D., Professor of Roentgenology and Chairman School of Roentgenology, Department of Medicine, University of Virginia, Charlottesville, Virginia.

W. E. Baensch, M.D., Professor of Roentgenology, Goergetown University Hospital, Washington, D.C.

Carl B. Braestrup, Senior Physicist, Department of Hospitals, New York City; Associate Professor of Radiology, New York University and Columbia University, New York, New York.

Ralph M. Caulk, M.D., Attending Radiologist and Medical Director of the Tumor Clinic, Garfield Memorial Hospital, Washington, D.C.

W. Edward Chamberlain, M.D., Professor of Radiology, Temple University Medical School and Head of the Department of Radiology, Temple University Hospital, Philadelphia, Pennsylvania.

Richard H. Chamberlain, M.D., Assistant Professor of Radiology, University of Pennsylvania, School of Medicine, Philadelphia, Pennsylvania.

Arthur E. Childe, M.D., Radiologist, Children's Hospital of Winnipeg; Associate Radiologist, Winnipeg General Hospital, Winnipeg, Manitoba, Canada.

K. E. Corrigan, Ph.D., Director, Research Division, Harper Hospital, Detroit, Michigan.

Edwin C. Ernst, M.D., Director, Radiological Department, Barnard Free Skin and Cancer Hospital, Saint Louis, Missouri.

Robert E. Fricke, M.D., F.A.C.R., Associate Professor of Radiology, Mayo Foundation, University of Minnesota; Consultant in Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minnesota.

- C. Allen Good, M.D., M.S. in Radiology. Assistant Professor of Radiology, Mayo Foundation, University of Minnesota; Radiologist, Mayo Clinic, Rochester, Minnesota.
- H. F. Hare, M.D. Radiologist, Lahey Clinic, Boston, Massachusetts.
- Richard M. Hewitt, M.A., M.D., Assistant Professor of Medical Literature, Mayo Foundation, University of Minnesota; Editor and Head of Division of Publications, Mayo Clinic, Rochester, Minnesota.
- Fred Jenner Hodges, M.D., Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.
- John F. Holt, M.D., Associate Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.
- Howard B. Hunt, M.D., Professor and Chairman of the Department of Radiology, University of Nebraska, College of Medicine, Omaha, Nebraska.
- Harold W. Jacox, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief of Radiotherapy Division of Radiological Service, Presbyterian Hospital, New York, New York.
- B. R. Kirklin, M.D., F.A.C.P., F.A.C.R., Professor of Radiology, Mayo Foundation, University of Minnesota; Radiologist and Chairman of Sections on Radiology, Mayo Clinic, Rochester, Minnesota.
- Isadore Lampe, M.D., Associate Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.
- Maurice Lenz, M.D., Professor of Clinical Radiology, Columbia University, New York; Consultant Radiotherapist to the Manhattan Eye, Ear and Throat Hospital, Montefiore Hospital and Presbyterian Hospital, New York, New York.
- Robert S. MacIntyre, M.D., Assistant Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.
- A. S. Macmillan, M.D., Radiologist, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts.
- Charles L. Martin, M.D., Professor of Radiology, Southwestern Medical College, Dallas, Texas.
- Henry G. Moehring, M.D. Radiologist, Duluth Clinic, Duluth, Minnesota; Formerly Director of School of Roentgenology at Army School of Roentgenology, Memphis, Tennessee.
- Edward B. D. Neuhauser, M.D., Associate in Radiology, Harvard Medical School, Boston, Massachusetts; Radiologist to The Infant's and to The Children's Hospitals of Boston.
- H. M. Parker, M.A., Ph.D., Manager of Health Instrument Divisions, General Electric Company Nucleonics Department, Richland, Washington.
- Lester W. Paul, M.D., Professor of Radiology, University of Wisconsin, Madison, Wisconsin.
- Carleton B. Peirce, A. B., M.Sc., M.D., F.A.C.P., Radiologist-in-Chief, Royal Victoria Hospital; Chairman, Department of Radiology, Faculty of Medicine, McGill University, Montreal, Quebec, Canada.
- Harold O. Peterson, M.D., Clinical Associate Professor of Radiology, University of Minnesota, Minneapolis, Minnesota; Radiologist to Miller Hospital and Children's Hospital, Saint Paul, Minnesota.
- Everett L. Pirkey, M.D., Associate Professor of Radiology, University of Louisville School of Medicine; Director, Department of Radiology, Louisville General Hospital, Louisville, Kentucky.
- Ernst A. Pohle, M.D., Ph.D., F.A.C.R., Professor of Radiology; Chairman, Department of Radiology, University of Wisconsin Medical School, Madison, Wisconsin.
- Leo G. Rigler, M.D., Professor of Radiology, University of Minnesota, Minneapolis, Minnesota.
- Wendell G. Scott, M.D., Associate Professor of Clinical Radiology, Washington University School of Medicine; Associate Director, Mallinckrodt Institute of Radiology, Saint Louis, Missouri.
- C. A. Stevenson, M.D., Head of the Department of Radiology, Scott and White Clinic, Temple, Texas.
- Marcy L. Sussman, M.S., M.D., Radiologist to the Mt. Sinai Hospital, New York; Clinical Professor of Radiology, Columbia University, New York; Phoenix, Arizona.
- Bernard P. Widmann, M.D., Chief Radiologist, Philadelphia General Hospital; Chairman of the Graduate School in Radiology, University of Pennsylvania, Philadelphia, Pennsylvania.

Conference Periods

Tuesday, Wednesday, Thursday and
Friday mornings

Single Periods.....8:30-10:00 A.M.

Location

All courses will be given in Parlors A, B, C, D, E, F, G, H, I, J, and L, located on the Fourth Floor of the Netherland Plaza Hotel. Full information may be obtained at the general registration desk which will be located near by.

Code

The instruction periods will be designated with the following code:

T, Tuesday.....8:30-10:00 A.M.
W, Wednesday.....8:30-10:00 A.M.
Th, Thursday.....8:30-10:00 A.M.
F, Friday.....8:30-10:00 A.M.

How to Register and Obtain Tickets for the Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following the list of titles and abstracts is a general order sheet. First, second and third choices for each period should be selected carefully and indicated on the order. The rooms in which the courses will be given are moderately large ones, but it will still be necessary to place a limitation on the number of persons who will be able to attend individual courses. It is estimated that the number who can attend will range between 50 and 100 persons. If the directions given on the order sheet are followed explicitly, errors in completing reservations will be minimized.

Persons requesting registration in one or more of the Sequential (continuous) Courses (A, B, C) should indicate second and third choices of single-period courses as substitutes for each period—this is to avoid disappointment should the Sequential Courses be filled when the order is received.

It is possible for one to attend only four periods of instruction, so the condensed schedule given on the last pages of this pro-

gram should be consulted with care when registering and ordering tickets.

Reservations will be made in the order in which the order forms are received. Those who are not members of the American Roentgen Ray Society will be charged the nominal fee of \$1.50 per period of instruction, or a maximal fee of \$5.00 for four periods. Full-time graduate students in Radiology will be admitted without fee, but they are required to make application for the courses they wish to attend.

Previous to September 24, 1949, the order forms should be sent to the Director, Dr. Harry M. Weber, Mayo Clinic, Rochester, Minnesota. After September 24, the orders should be sent directly to Dr. Harry M. Weber, Netherland Plaza Hotel, Cincinnati, Ohio.

In case the courses are not filled by the time of the meeting, tickets will be available at the registration desk on Sunday, October 2, and thereafter during the meeting.

Holders of Tickets

Those who do not have the proper ticket for the course they wish to attend will not be permitted to enter the room. Pages will be in attendance in each of the conference rooms to collect the tickets.

DESCRIPTION OF COURSES

I. The Symposium on Radioactive Isotopes

COURSE 101

Room L

Period: F

CARL B. BRAESTRUP, Ph.D.,
New York, N. Y.

Planning the Hospital Radioisotope Facilities

Setting up a radioisotope program involves the appointment of a supervising committee in the hospital, obtaining suitable laboratory space, securing competent personnel to do the actual work, pro-

curing the necessary equipment and instruments for safe handling and proper measurement of isotopes, and filing the necessary forms with the Atomic Energy Commission.

All these requirements will be discussed and detailed consideration will be given to instrumentation and radiologic safety.

COURSE 102

Room L

Period: T

K. E. CORRIGAN, Ph.D.,
Detroit, Mich.

Radioactive Isotopes, Their Production and Properties

A brief summary of the historical background with the derivation and precise meaning of modern isotope terminology will introduce the course. The useful methods of production, including low and high voltage accelerators, the cyclotron and the nuclear reaction pile with the type of isotopes produced by each, will be discussed. Transmutation reactions and the preparation and purification of useful isotopes will be considered. The properties which make certain radioisotopes useful in medical diagnosis and therapy will be considered in detail. The limitations on the choice of an isotope, particularly with respect to the radiological toxicity of the long-lived isotopes, will be presented. The course will include the practical classification of the medically useful isotopes as they are known at the present time, both with respect to their use in elemental or simple inorganic forms, and to the present status and future possibilities of more complex organic compounds.

COURSE 103

Room L

Period: Th

HOWARD B. HUNT, M.D.,
Omaha, Nebraska

Practical Utilization of Radioisotopes in Radiotherapy

A practical presentation of the principles of protection, radioassay, instrumentation, clinical indications, dosimetry and therapeutic results essential to utilization of radioiodine in thyroid disease and radiophosphorus in polycythemia and leukemia.

II. Sequential Courses

COURSE A

(2 periods)

Room A

Periods: Th; F

CARLETON B. PEIRCE, M.D.,
Montreal, Quebec

Radiation Therapy of Malignant Neoplasms Involving the Brain and Central Nervous System

A brief survey of the types of

(a) Primary neoplasms

(b) Common systemic neoplasms

(c) Common metastatic neoplasms affecting the brain, brain stem and cord will be followed by a discussion of the characteristics of each which affect the selection of cases for irradiation.

This discussion will be further elaborated with a consideration of such methods of irradiation, in which the major emphasis will be given to the procedures used in the Royal Victoria Hospital and the Montreal Neurological Institute.

Certain special problems, such as medulloblastoma, the systemic neoplasms, such as the lymphogranuloma group and the common metastatic carcinoma will be included if time permits.

COURSE B

(2 periods)

Room G

Periods: Th; F

HAROLD O. PETERSON, M.D.,
St. Paul, Minn.

The Roentgenologic Examination of the Urinary Tract

The material for this course has been taken from an active urologic service at the Miller Hospital in St. Paul, Minnesota, supplemented by cases from University of Minnesota Hospitals. The course will deal largely with intravenous or excretion urography. It will be divided into two parts. In the first period the routine procedures will be thoroughly discussed, including the preparation of the patient, use of cathartic drugs, pitressin, dehydration, types of contrast media used, compression, time interval for films, position of patient, etc. Also presented in this first period will be the excretory urographic appearance of the normal urinary tract, and the variations from the normal which are not considered to have pathologic significance. In the second period the lesions of the urinary tract will be presented together with some of the important congenital anomalies of the urinary tract which can be recognized by intravenous urography.

Emphasis will be placed on practical procedures and on the urologic abnormalities more commonly encountered, rather than on the theoretical and the unusual. Original roentgenograms will be used for illustration with the use of a special projector.

COURSE C

(2 periods)

Room I

Periods: Th; F

MARCY L. SUSSMAN, M.D.,
Phoenix, Arizona

Angiocardiographic Technique and Interpretation

This course will present a discussion of angiocardiography including the technique, the applications and the limitations. Particular attention will be paid to the results obtained in congenital heart disease, in cor pulmonale, in mitral disease, and in lesions of the lung and mediastinum. More briefly, techniques such as cardiac catheterization will be considered in their relation to problems in which angiocardiography is useful.

III. Special Courses

COURSE S-1

Room J

Period: Th

RICHARD M. HEWITT, M.D.,
Rochester, Minn.

Writing of Medical Papers

Some tricks of the trade which assist the journeyman medical writer in construction of his whole essay, his paragraphs, his sentences and his tabular and textual stereoptican slides.

COURSE S-2

Room L

Period: W

H. M. PARKER, M.A., Ph.D.,
Richland, Wash.

Radiation Dosimetry

1. Roentgen rays and gamma rays:
Advantages of an ionization method.
Interpretation of the original definition of the "roentgen".
Energy absorption and the Bragg-Gray Principle.

Interpretation of the current definition of the "roentgen".

The gamma-roentgen.

Complexities with multi-million volt radiation.

2. Other radiations:

Extension of the roentgen to particulate radiations.

Gray's Energy Unit.

The "rep".

Applications to radioisotope therapy and neutron therapy.

Other proposals for physical dose units.

3. Factors of biological effectiveness:

Relative biological effectiveness.

The "rem".

Scale of relation between "rep" and "rem".

Severe limitations of the "rem".

IV. Therapeutic Radiology

COURSE 201

Room D

Period: T

RALPH M. CAULK, M.D.,
Washington, D. C.

Transvaginal Roentgen Therapy in Carcinoma of the Cervix Uteri

Roentgen therapy by the transvaginal method has been used in the treatment of over 450 cases since October, 1946, in the Department of Roentgen Therapy at the Garfield Memorial Hospital.

Experience indicates that this is one of the most efficacious methods by which the primary tumor can be modified and controlled.

Apparatus, technique and dosage will be demonstrated, both by lantern slides and on a wax model.

The place of this method in the treatment schema will be discussed.

Results in terms of five year survivals and the complications incurred, will be fully emphasized.

COURSE 202

Room G

Period: T

W. EDWARD CHAMBERLAIN, M.D.,
Philadelphia, Pa.

Some Harmful Effects of Irradiation and Their Avoidance

Irradiation is a two-edged sword. Correctly applied in a properly selected case its potentialities for good may be boundless: its potentialities for harm must, however, be borne in mind at all times. When

irradiation is applied in the treatment of a benign condition, resultant harm to normal structures will not be acceptable.

Cases will be presented in which harm resulted from (a) a single exposure, (b) a series of relatively minute exposures. There will be emphasis upon the significance of the interval between small exposures and evidence will be produced to indicate that great caution is necessary in the use of irradiation for such conditions as acne, epidermophytosis, psoriasis, and the common wart.

COURSE 203

Room J

Period: T

RICHARD H. CHAMBERLAIN, M.D.,
Philadelphia, Pa.

Low Voltage-Short Distance Therapy

In the treatment of superficial and accessible lesions, roentgenologic apparatus which produces long wavelength roentgen rays and can be operated at short distances may offer appreciable advantages. Precise control of depth dosage, easy and quick application, and good uniformity of field coverage is possible. Beryllium window tubes now enlarge the scope of radiation quality obtainable.

In clinical practice, new judgments of dosage are necessary. Excellent results are obtained in accessible epitheliomas, superficial metastases, hemangiomas, benign conditions of the cornea and sclera. The avoidance of unfavorable deep radiation effects and the optimal cosmetic results are particularly gratifying.

COURSE 204

Room C

Period: F

E. C. ERNST, M.D.,
St. Louis, Mo.

Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri

SYNOPSIS

- (a) *Clinical Management and Preliminary Considerations*
- (b) *Indications for Roentgen Therapy:*
 1. Indirect irradiation of the pelvis.
 2. Direct (intravaginal) roentgen-ray applications.
- (c) *Essential Tumor Dose Measurement Factors*
- (d) *Indications for Radium Therapy:*
 1. Evaluation of the various methods and the intracervical applicators.
 2. Essential minimum requirements for obtaining the ideal uniform distribution of radium radiations.

(e) *Prognostic Factors:*

1. Tumor grading.
2. Stage of the disease.
3. Initial response to preliminary roentgen irradiation.

(f) *Final Discussion Period:*

- Case presentations.
2. Questions (15 minutes).

ABSTRACT

The practical irradiation management of carcinoma of the cervix will be discussed both from the standpoint of the institutional tumor clinic and the private office procedure. Although realizing that the radiation treatment standards continue to remain somewhat in a state of flux and that individualization in the application of roentgen rays and radium is a most essential consideration, nevertheless certain fundamental concepts in our routine procedures are most helpful in the management of cancer of the cervix. These and many other practical therapeutic considerations, including external roentgen therapy, intracavity radium and roentgen methods of treatment and the dosage measurement problems, will be discussed and illustrated.

COURSE 205

Room J

Period: F

R. E. FRICKE, M.D.,
Rochester, Minn.

Beta Irradiation in Diseases of the Eye

The elementary physics of beta particles will be discussed. Work in various centers has shown promising healing in the treatment of early corneal ulcers, leukoma, benign papillomas, vernal conjunctivitis, recurring pterygium and other inflammatory dyscrasias. Early results are good. Beta particles are furnished by applicators containing radon, radium D or radioactive strontium. Dosage problems will be considered, and apparatus designed and used at the Mayo Clinic for radium D therapy will be shown.

COURSE 206

Room C

Period: W

HUGH F. HARE, M.D.,
Boston, Mass.

Symposium—Cancer of the Thyroid

Thyroid cancers arise in pre-existing tumors. The clinical evaluation of an individual case does not ex-

clude cancer. Single thyroid nodules are malignant in 10 per cent of the cases coming to operation. We believe radical surgery followed by roentgen therapy is the treatment of choice with the exception of malignant fetal adenomata, which we do not believe are clinically malignant.

A roentgen-ray tumor dose of 4,800 to 6,000 roentgens is necessary to control the growth of papillary cyst adenocarcinoma, papillary adenocarcinoma, and small cell carcinoma. Giant cell carcinoma does not respond to doses of roentgen rays as outlined here. Radium is the useful adjunct in residual and infiltrative tumor, especially adenocarcinoma. An attempt should be made to give at least 6,000 gamma roentgens to the periphery of the tumor.

Ten to twenty year follow-up studies show that good results have been obtained in the treatment of (a) fetal adenomata with malignant transformation; (b) papillary cyst adenocarcinoma; (c) papillary adenocarcinoma. Poor results are obtained in the treatment of alveolar adenocarcinoma and giant cell carcinoma. The failure of treatment of the small cell type of thyroid cancer is usually a result of its widespread infiltration at the time the patient presents himself for treatment.

Associated hyperthyroidism is rare in thyroid cancer, occurring approximately in 8 per cent. Radioactive iodine as a method of treatment will be discussed.

COURSE 207

Room C

Period: Th

HAROLD W. JACOX, M.D.,
New York, N. Y.

Radiation Treatment of Tumors of the Kidney and Adrenal Glands

Since these tumors are primarily of surgical importance an attempt will be made to correlate the urologic and radiologic viewpoints.

Highlights of the clinical aspects of interest to radiologists will be given. Technical procedures rather than statistical results will be emphasized. Some of the difficult problems will be illustrated by case reports.

COURSE 208

Room J

Period: W

ISADORE LAMPE, M.D.,
Ann Arbor, Mich.

Radiation Therapy of Selected Miscellaneous Non-Malignant Conditions

A discussion of clinical indications, value and tech-

niques of radiation therapy in the following conditions:

Simple inflammations and infections
Acute parotitis
Acute postpartum mastitis
Tuberculous lymphadenitis
Rheumatoid spondylitis
Myasthenia gravis
"The thymus".

COURSE 209

Room C

Period: T

MAURICE LENZ, M.D.,
New York, N. Y.

Roentgen Therapy of Cancer of the Breast

Experience with roentgen therapy of mammary cancer at Presbyterian Hospital, New York, between 1923 and 1944 will be discussed. Five year arrests by this treatment has required tumor doses of 6,000 to 8,000 roentgens in three to four months. This has been practical only in tumors limited to the breast and the axilla. Smaller dosage has resulted in growth restraint of shorter duration.

COURSE 210

Room D

Period: F

CHARLES L. MARTIN, M.D.,
Dallas, Texas

Treatment of Cancer of the Face, Mouth and Metastatic Cervical Lymph Nodes with Irradiation

All carcinomas of the face and mouth, regardless of their size, are treated with either roentgen therapy or low intensity radium needles. In many instances electrosurgery is used as a preliminary procedure to reduce the tumor to a flat plane or to remove involved cartilage. Metastatic lymph nodes in the neck are treated by a combination of roentgen therapy and low intensity radium needles. Details of technique, illustrative cases and statistical results will be presented with the aid of lantern slides.

COURSE 211

Room A

Period: T

ERNST A. POHLE, M.D.,
Madison, Wisconsin

Radiation Therapy of Vascular Nevi

Vascular nevi of the skin may be divided into five groups: (1) capillary hemangiomas (port wine

stain); (2) hemangioma simplex (strawberry mark); (3) cavernous hemangioma; (4) spider-like capillary telangiectasia; (5) lymphangioma. Treatment recommended by various authors consists of (a) injection with a sclerosing solution (quinine-urethane); (b) CO₂ snow; (c) radium; (d) roentgen rays; (e) desiccation. In the Department of Radiology at the University of Wisconsin we have used radium in the majority of our cases; roentgen rays occasionally, especially for large lesions, and desiccation for the spider-like nevus. The techniques of treatment and the results obtained will be discussed in detail.

COURSE 212

Room D

Period: W

BERNARD P. WIDMANN, M.D.,
Philadelphia, Pa.

Bronchogenic Carcinoma—Radiation Treatment

Bronchogenic carcinoma is curable only by radical surgery. The incidence of operability is relatively slight. The preponderance of cases must be regarded for palliative irradiation or no treatment. This discussion will be an attempt to classify the results of roentgen treatment of bronchogenic carcinoma at the Philadelphia General Hospital during the past twenty years. The beneficial effects with special reference to the longevity cycle have been tabulated in a series of more than 400 cases. A manifold variety of techniques, as well as the skin and physical tolerance for varying rates and total doses, has been analyzed according to the results obtained. The beneficial effects of irradiation are very definite for about one-third of the treated cases. The longevity cycle is not appreciably altered even for the patients who are improved in health and strength and clinically very much benefited. This experience, however, emphasizes the importance and necessity of cultivating more interest and enthusiasm for a greater effort to carry out irradiation more systematically and vigorously for bronchogenic carcinoma.

V. Diagnostic Roentgenology

COURSE 301

Room B

Period: T

V. W. ARCHER, M.D.,
University, Virginia

Diagnosis of Bone Tumors

On the basis of experience with proved cases of bone tumor the difficulty of precise roentgenologic diagnosis of many of them will be discussed. Mis-

leading original pathologic reports and misleading clinical symptoms often add to the diagnostic difficulties. The role of blood chemistry studies, biopsy, roentgenologic data, clinical history and examinations will be stressed. Lesions simulating malignant tumors of bone will be shown and discussed.

COURSE 302

Room B

Period: W

W. E. BAENSCH, M.D.,
Washington, D. C.

The Mucosal Pattern of the Stomach and Duodenum

A technique of demonstrating the pattern of the mucous membrane of the stomach and duodenum will be described. The physiologic basis for the development of the normal pattern will be discussed and compared with the changes in the pattern developed in various gastric and duodenal diseases. Emphasis will be placed on the practical aspects of roentgenologic observations of this kind.

COURSE 303

Room E

Period: T

ARTHUR E. CHILDE, M.D.,
Winnipeg, Manitoba

The Manifestations of Intracranial Disease in Plain Roentgenograms of the Skull

This course will deal with the evidence of intracranial disease revealed in roentgenograms of the skull made without the use of contrast media. Such manifestations of intracranial disease will be discussed as intracranial calcification, changes in the bony structure of the calvarium, changes in the sella turcica, calcification of the pineal gland and significant displacement of its shadow, changes in the vascular markings of the calvarium. Lesions of the scalp and of the skull which sometimes simulate the manifestations of intracranial disease will also be given due consideration.

COURSE 304

Room E

Period: W

ARTHUR E. CHILDE, M.D.,
Winnipeg, Manitoba

The Normal Encephalogram and Ventriculogram Congenital Abnormalities of the Brain

The roentgen technique of cerebral pneumography will be discussed and the importance of a few simple

manipulations of the head during this procedure will be explained. This will be followed by a review of the normal anatomy of the ventricular system, basal cisterns and cortical markings. The pneumographic features of various congenital abnormalities will be shown.

COURSE 305

Room E

Period: Th

ARTHUR E. CHILDE, M.D.,
Winnipeg, Manitoba

The Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions

The deformities produced by various types of expanding intracranial lesions will be shown. Encephalography is often used to determine the cause of epileptic seizures in patients who do not suffer from brain tumors, and some examples of atrophic and contracting intracranial lesions will also be illustrated.

COURSE 306

Room F

Period: W

C. ALLEN GOOD, M.D.,
Rochester, Minn.

The Roentgenologic Diagnosis of Surgical Lesions of the Mediastinum

With recent advances in thoracic surgery has come an increasing need for more accurate diagnosis of mediastinal lesions. This responsibility rests largely on the roentgenologist.

This course will include a discussion of the criteria for roentgenologic diagnosis of the lesions of the mediastinum which are generally considered to require surgical treatment. The lesions will be discussed in groups according to their origin in the anterior, middle or posterior mediastinum. Lesions of cardiac or of pulmonary origin will not be included except as they enter the differential diagnosis.

COURSE 307

Room E

Period: F

FRED JENNER HODGES, M.D.,
Ann Arbor, Mich.

Intracranial Angiography

The indications for this type of examination will be outlined and the required technical procedures

will be discussed. Examples of angiographic results in the examination of various patients typifying the major forms of intracranial abnormality which can be detected by this method will be presented.

Although this is a very highly specialized form of roentgen diagnosis with a relatively narrow field of application, the degree of diagnostic accuracy which it brings to neurosurgical problems is not to be overlooked. Even though a radiologist does not employ it himself he should be fully aware of its potentialities.

COURSE 308

Room B

Period: Th

JOHN F. HOLT, M.D.,
Ann Arbor, Mich.

The Diagnosis of Benign and Malignant Tumors of Bone

A discussion of the virtues and limitations of roentgenology in the evaluation of destructive and proliferative lesions in bone due to neoplasm and allied diseases. Using illustrative roentgenograms, emphasis will be placed on significant generalities rather than minor details of individual lesions with the idea of clarifying the true position of the roentgen method in this important but somewhat controversial field of diagnosis.

COURSE 309

Room G

Period: W

B. R. KIRKLIN, M.D.,
Rochester, Minn.

Cholecystographic Technique

The importance of meticulous technique in cholecystography will be discussed.

COURSE 310

Room F

Period: F

ROBERT S. MacINTYRE, M.D.,
Ann Arbor, Mich.

Pulmonary Tuberculosis

Roentgenologic methods are well established in the detection and treatment of pulmonary tuberculosis. The uses and limitations of these methods will be discussed. Special attention will be given to the importance of childhood tuberculosis and of minimal tuberculous lesions in the adult. The basis for a practical approach in the handling of any given

patient will be emphasized. Selected roentgenograms will be used as illustrative material.

COURSE 311

Room H

Period: T

A. S. MACMILLAN, M.D.,
Boston, Mass.

Roentgen Examination of the Sinuses

1. Roentgen examination of the sinuses is a very important part of the diagnosis of pathology in these locations. The rhinologist is dependent upon a correct interpretation of the sinus roentgenograms. The findings should be reported in terms of pathology, and not in the indefinite roentgenological terms so often used. In this presentation, the technique of examination and interpretation will be considered as fully as time will allow.

COURSE 312

Room H

Period: W

A. S. MACMILLAN, M.D.,
Boston, Mass.

Roentgen Examination of the Mastoids

2. The use of chemotherapy and antibiotics has greatly changed the course of infection in the mastoid. Pediatricians and general medical practitioners sometimes feel competent to treat this condition, but too often the treatment is inadequate. The roentgenologic examination of the mastoid is the only dependable source of information. This should be recognized because mastoiditis is still prevalent. Acute and chronic infections of the mastoid and the complications will be discussed.

COURSE 313

Room H

Period: Th

A. S. MACMILLAN, M.D.,
Boston, Mass.

3. *The film reading session* will consider conditions met in a hospital devoted to treatment of the sinuses, mastoids and abnormalities of the esophagus. Rare and unusual conditions are often emphasized in a presentation such as this, with failure to give adequate consideration to the more common types of pathology met with every day. This discussion will deal with the more commonly encountered ab-

normalities in which roentgenologic assistance is sought.

The new projector developed by Doctors Dillon and Murphy which makes it possible to show four original roentgenograms of the sinuses at one time will be used.

COURSE 314

Room F

Period: Th

HENRY G. MOEHRING, M.D.,
Duluth, Minn.

Bronchographic Technique and Interpretation

A discussion of the anatomy of the bronchial tree and its nomenclature will introduce considerations of the clinical importance of the bronchopulmonary segments, several techniques for bronchography, and the chief indications for bronchography.

COURSE 315

Room I

Period: T

EDWARD B. D. NEUHAUSER, M.D.,
Boston, Mass.

The Roentgen Diagnosis of Congenital Cardiovascular Abnormalities Amenable to Surgery

Many forms of congenital malformation of the heart and great vessels, long considered of academic interest only, are now surgically correctible. Recent advances in roentgen diagnosis and in surgical techniques are leading to the recognition of abnormalities which have been overlooked in the past, and have led to the more accurate diagnosis of many malformations whose major features have long been known.

The roentgen features of patent ductus arteriosus, coarctation of the aorta, stenosis of the pulmonary artery, tetralogy of Fallot, Corvisart's complex, double aortic arch, vascular rings constricting the trachea and esophagus, and anomalies of the right subclavian artery and of the innominate vein should be familiar to all roentgenologists. The diagnostic criteria of these malformations will be discussed.

COURSE 316

Room A

Period: W

EDWARD B. D. NEUHAUSER, M.D.,
Boston, Mass.

Certain Aspects of the Gastrointestinal Tract in Infants and Young Children

In this course, no effort will be made to cover all the possible abnormalities and diseases that are seen

or which reflect themselves in abnormalities of the alimentary tract.

Particular attention will be given to the technique of examination of the esophagus and gastrointestinal tract in infants and in young children and also to the technique of examination of the colon in infants.

Particular attention will be devoted to congenital anomalies and resulting diseases of the esophagus, certain unusual forms of herniation of the bowel into the thorax, and considerable attention will be given to the problems of duplication of the alimentary tract.

Malrotation of the bowel, congenital stenosis and atresia and study of the patient with imperforate anus will be discussed.

Several other anomalies and acquired lesions will be discussed briefly.

COURSE 317

Room D

Period: Th

LESTER W. PAUL, M.D.,
Madison, Wisconsin

The Roentgenology of the Rheumatic Diseases

This course will include a discussion of the role of roentgen examination in the diagnosis of the various diseases of the joints and periarticular structures. A classification of arthritis suitable for both roentgen and clinical use will be given. The pathologic basis for the changes visualized by roentgen examination will be covered briefly. Major emphasis in the course will be placed upon the correlation of the roentgenologic and clinical manifestations of the various types of joint disease, and upon the roentgenologic signs by which these types are distinguished from each other, and by which progression from early to late stages is followed.

COURSE 318

Room B

Period: F

EVERETT L. PIRKEY, M.D.,
Louisville, Kentucky

Differential Diagnosis of Lesions in and About the Fundus of the Stomach

- I. Review of principal anatomical relations about the stomach.
- II. Evolution of methods for diagnosis of gastric lesions.
- III. Description of our new method.
- IV. Indications for use.
- V. Typical cases demonstrating its value.

COURSE 319

Room F

Period: T

LEO G. RIGLER, M.D.,
Minneapolis, Minn.

Roentgen Manifestations of Bronchogenic Tumors

The roentgen findings obtained with various types of bronchogenic tumors will be discussed with particular reference to the following:

1. The possibilities and limitations of roentgen diagnosis of bronchogenic tumors.
2. The roentgen delineation of the tumor mass.
3. Inflammatory changes associated with bronchogenic tumors.
4. The roentgen evidences of bronchial obstruction such as emphysema, atelectasis, and secondary inflammatory changes.
5. The demonstration of the bronchial tumor by bronchography and planigraphy.
6. The special findings in bronchial adenoma.

Diagrams and reproductions of roentgenograms will be demonstrated to illustrate these various findings.

COURSE 320

Room I

Period: W

WENDELL G. SCOTT, M.D.,
St. Louis, Mo.

Angiographic Procedures in the Diagnosis of Congenital Heart Disease

This course will include a discussion of the development and description of equipment for the rapid automatic serialization of roentgen exposures synchronized with a Potter-Bucky grid with special emphasis on the use of the Rapidograph with roll film.

The techniques of injection for both cardiovascular angiography and aortography will be discussed.

Indications and contraindications for the use of angiographic procedures as related to the diagnosis of congenital heart disease will be mentioned. A series of lantern slides will be used to demonstrate the roentgenographic findings in various types of congenital heart disease.

COURSE 321

Room H

Period: F

C. A. STEVENSON, M.D.,
Temple, Texas

The Conduct of the Roentgenologic Examination
of the Colon

The roentgenologist is responsible for the detection of any organic lesion of the colon above the level of proctoscopic reach. In order to accept this responsibility, many exacting criteria must be fulfilled.

The subjects to be discussed are (1) detailed consideration of the methods of preparing the patient for the intestinal examination; (2) comparison of various suspensions of barium; (3) mechanical aids used during the roentgenoscopic examination; (4) roentgenoscopic procedure, and (5) roentgenographic technique.

Studies on the nature of pseudo-polyps and their differentiation from true polyps will be discussed. Emphasis will be given to the method of producing superior double contrast films.

Section on Instruction ORDER SHEET

It is important to register for the Instruction Courses as early as possible since the number admitted to each course will be limited. *It is also very important that first, second and third choices be listed for each period.* All orders for tickets will be filled according to the postmark on the envelopes.

Non-members of the American Roentgen Ray Society, except full time graduate students in Radiology, will pay \$1.50 for each course-period or a maximum of \$5.00 for 4 courses. Non-members' fees must accompany this order sheet and will not be returned unless cancellation is received before October 1, 1949.

Fill out the following (type or print):

.....
Last Name First Name or Initials

Check

☐ Member

☐ Guest

☐ Graduate Student
in Radiology at:

.....
Street Address

.....
City State

For convenience in selecting your courses, consult the condensed schedule on the following pages.

CLAIMING INSTRUCTION COURSE TICKETS

Beginning Sunday, October 2, 1949, those who have sent in advance orders may secure their tickets at the Registration Desk. Tickets may also be obtained for courses not filled.

Please remember that the Sequential Courses are continuous ones and run in two periods. *No part of them is repeated.* All other courses are single-period courses.

BE SURE TO FILL OUT SECOND AND THIRD CHOICES FOR EACH PERIOD

Period	First Choice		Second Choice		Third Choice	
	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Tuesday						
Wednesday						
Thursday						
Friday						

Previous to September 24, 1949, send this order sheet to:
DR. HARRY M. WEBER, MAYO CLINIC, ROCHESTER, MINNESOTA.
After September 24, 1949, mail to:
DR. HARRY M. WEBER, AMERICAN ROENTGEN RAY SOCIETY,
NETHERLAND PLAZA HOTEL, CINCINNATI, OHIO.

CONDENSED SCHEDULE OF COURSES ON TUESDAY, OCT. 4

Code: T

8:30 A.M.—10:00 A.M.

Code: T

Therapeutic Radiology and Radiation Physics

Diagnostic Roentgenology

201—Caulk	Transvaginal Roentgen Therapy in Carcinoma of the Cervix Uteri	301—Archer	Diagnosis of Bone Tumors
202—Chamberlain, W. E.	Harmful effects of Irradiation and Their Avoidance	303—Childe	Manifestations of Intracranial Disease in Plain Roentgenograms of the Skull
203—Chamberlain, R. H.	Low Voltage-Short Distance Therapy	311—Macmillan	Roentgen Examination of the Sinuses
102—Corrigan	Radioactive Isotopes, their Production and Properties	315—Neuhauser	Roentgen Diagnosis of Congenital Abnormalities Amenable to Surgery
209—Lenz	Roentgen Therapy of Cancer of the Breast	319—Rigler	Roentgen Manifestations of Bronchogenic Tumors
211—Pohle	Radiation Therapy of Vascular Nevi		

CONDENSED SCHEDULE OF COURSES ON WEDNESDAY, OCT. 5

Code: W

8:30 A.M.—10:00 A.M.

Code: W

Therapeutic Radiology and Radiation Physics

Diagnostic Roentgenology

206—Hare	Cancer of the Thyroid	302—Baensch	Mucosal Pattern of the Stomach and Duodenum
208—Lampe	Radiation Therapy of Selected Miscellaneous Non-Malignant Conditions	304—Childe	Normal Encephalogram and Ventriculogram; Congenital Abnormalities of the Brain
S-2—Parker	Radiation Dosimetry	306—Good	Roentgenologic Diagnosis of Surgical Lesions of the Mediastinum
212—Widmann	Bronchogenic Carcinoma	309—Kirklin	Cholecystographic Technique
		312—Macmillan	Roentgen Examination of the Mastoids
		316—Neuhauser	Gastrointestinal Tract in Infants and Young Children
		320—Scott	Angiographic Procedures in the Diagnosis of Congenital Heart Disease

CONDENSED SCHEDULE OF COURSES ON THURSDAY, OCT. 6

Code: Th

8:30 A.M.—10:00 A.M.

Code: Th

Therapeutic Radiology and Radiation Physics

Diagnostic Roentgenology

103—Hunt	Practical Utilization of Radioisotopes in Radiotherapy	305—Childe	Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions
207—Jacox	Radiation Treatment of Tumors of the Kidney and Adrenal Glands	308—Holt	The Diagnosis of Benign and Malignant Tumors of Bone
A—Peirce	Radiation Therapy of Malignant Neoplasms Involving the Brain and Central Nervous System	313—Macmillan	Film Reading Session
		314—Moehring	Bronchographic Technique and Interpretation
S-1—Hewitt	Writing of Medical Papers	B—Peterson	Roentgenologic Examination of the Urinary Tract
		C—Sussman	Angiocardiographic Technique and Interpretation
		317—Paul	Roentgenology of the Rheumatic Diseases

CONDENSED SCHEDULE OF COURSES ON FRIDAY, OCT. 7

Code: F

8:30 A.M.—10:00 A.M.

Code: F

Therapeutic Radiology and Radiation Physics

Diagnostic Roentgenology

101—Braestrup	Planning the Hospital Radioisotope Facilities	307—Hodges	Intracranial Angiography
204—Ernst	Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri	310—MacIntyre	Pulmonary Tuberculosis
205—Fricke	Beta Irradiation in Diseases of the Eye	B—Peterson	Roentgenologic Examination of the Urinary Tract
210—Martin	Treatment of Cancer of the Face, Mouth and Metastatic Cervical Lymph Nodes with Irradiation	318—Pirkey	Differential Diagnosis of Lesions in and about the Fundus of the Stomach
A—Peirce	Radiation Therapy of Malignant Neoplasms Involving the Brain and Central Nervous System	321—Stevenson	Conduct of Roentgenologic Examination of the Colon
		C—Sussman	Angiocardiographic Technique and Interpretation

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

- WHITE, J. C., LIU, C. T., and MIXTER, W. J.:
Focal epilepsy..... 150
NATHANSON, L., and LOSNER, S.: Ossification
of auricles of external ears associated with
acromegaly..... 150
CHILDE, A. E., and YOUNG, A. W.: Pneumo-
graphic diagnosis of intraventricular epi-
dermoid..... 150
KING, J. E. J.: Diploic epidermoid and extra-
dural pneumatocele..... 151
VAN METRE, T. E., JR.: Malignant tumors of
the nasopharynx..... 151

Neck and Chest

- MCCLENDON, J. F., FOSTER, W. C., and CAV-
ETT, J. W.: Attempt to explain the anoma-
lous action of Lugol's solution in exoph-
thalmic goiter..... 151
WYMAN, A. C.: Primary atypical pneumonia.. 151
MORGAN, R. H.: Roentgenologic diagnosis of
tuberculosis..... 152
LINCOLN, EDITH M., STONE, S., and HOFFMAN,
OLGA R.: Treatment of miliary tuberculo-
sis with promizole..... 152
LIVINGSTON, S.: Sedimentation rate in asthma
in children..... 152
LENÈGRE, J., KILADONIS, P., and DE BRUX, J.
Calcifications of the ascending aorta..... 153
MELAMED, A., and WALKER, L. J.: Dissecting
(intramural) pharyngo-esophageal divertic-
ulum..... 153

Abdomen

- BRUMMER, P., and BUNDUL, A.: On the effect of

- some common gastric drugs on the motil-
ity of the stomach..... 153
FERGUSON, I. A.: Prolapse of the gastric mu-
cosa..... 153
KIRSNER, J. B., PALMER, W. L., MAIMON, S. N.
and RICHTETS, W. E.: Clinical course of
chronic nonspecific ulcerative colitis..... 154
PRESENT, A. J., and GEYMAN, M. J.: Diffuse
calcification of the pancreas..... 154

Gynecology and Obstetrics

- HOWSON, J. Y.: Pelvic cancer delay..... 155
SCHEFFEY, L. C., RAKOFF, A. E., and HOFF-
MAN, J.: Evaluation of vaginal smear
method for diagnosis of uterine cancer... 155

Skeletal System

- OLDFELT, C. O.: Renal osteodystrophy..... 156
ENELL, H.: Renal osteodystrophy..... 156
STEINBROCKER, O., SPITZER, N., and FRIED-
MAN, H. H.: Shoulder-hand syndrome.... 156
GILBERT, R., and VOLUTER, G.: Roentgen
study of concurrent skin and bone changes
in the leg..... 157
HIGHSMITH, L. S., and PHALEN, G. S.: Side-
swipe fractures..... 157
LYFORD, J., III, JOHNSON, R. W., JR., BLACK-
MAN, S., and SCOTT, R. B.: Pathologic find-
ings in a fatal case of disseminated granu-
loma inguinale with miliary bone and joint
involvement..... 157
OOSTHUIZEN, S. F., and BARNETSON, J.: Two
cases of lipomatosis involving bone..... 158
SHALLOW, T. A., and WAGNER, F. B.: Pulsat-
ing benign giant cell tumors of bone..... 158
MCMURRAY, B.: Report of six cases of coxa
magna following synovitis of hip joint.... 158

ROENTGEN DIAGNOSIS

HEAD

WHITE, J. C., LIU, CHING TUNG, and MIXTER, W. J. Focal epilepsy; epilepsy secondary to intracranial tumors. *New England J. Med.*, June 24, 1948, 238, 891-899.

Of 1,130 patients admitted to the Massachusetts General Hospital with all varieties of epilepsy in the decade 1935 through 1944, 240, or 21 per cent, had seizures arising from a focal area that could be localized by clinical examination, roentgen studies, or electroencephalography. The seizures in the 240 patients were usually, but not always, of the jacksonian type. Of the 240 cases, 160 were caused by intracranial tumors, and 80 by trauma or infection. All of the cases were surgically explored.

The 160 cases caused by tumor constituted 25 per cent of a group of 641 brain tumors operated on during the same decade. In the latter group, the incidence of seizures varied with the location of the tumor, being highest for tumors close to the motorsensory areas of the cerebral cortex, and lowest for infratentorial neoplasms. Tumors situated deeply in the basal ganglia or third ventricle rarely gave rise to seizures.

Age of onset is an important factor to consider in determining the etiology of seizures. When epilepsy begins in adult life with a previous history of cranial trauma, abscess, or encephalitis, the most probable diagnosis is brain tumor.

Grouping of tumors by cytologic origin shows that the greatest incidence of seizures occurs in the most slowly growing tumors: astrocytoma (50 per cent), meningioma (35 per cent), oligodendroglioma (37 per cent), and hemangioma (33 per cent). Glioblastoma multiforme and metastatic carcinoma have lesser epileptogenic tendencies (22 per cent and 14 per cent respectively). However, in those cases of glioblastoma where seizures did appear, they were the first evidence of the disease in 75 per cent. Pituitary tumors produce seizures only after escaping the sella to invade the cerebral hemispheres.

Postoperatively, epilepsy accompanying brain tumor is often ameliorated and sometimes completely relieved. Epilepsy not present before operation occasionally appears postoperatively. —Henry P. Brean, M.D.

NATHANSON, LOUIS, and LOSNER, SAMUEL. Ossification of auricles of external ears asso-

ciated with acromegaly. *Radiology*, Jan., 1947, 48, 66-68.

The authors report their findings in a patient with classical acromegaly in whom marked calcification or ossification was noted in the lobes of both ears. The ears were roentgenographed because of their appearance and rigidity. Both auricles revealed involvement of the entire cartilage. Because of the trabeculated appearance of the calcified structure, the authors thought they were dealing with bone rather than ordinarily deposited calcium.

Reviewing the literature, it was learned that cartilage frequently undergoes changes of a proliferative and generative nature in acromegaly. Similar calcification and ossification may take place in the ribs, intervertebral discs, trachea and larynx.

Pathologically, the process is characterized by an increase in cartilaginous cells and intercellular substance which leads to a distention of the transitional zone between bone and cartilage. Followed by degeneration with liquefaction and formation of vacuoles in the deficient cartilaginous tissue, the process eventuates in ossification which may take place with or without previous calcification.—Philip J. Hodes, M.D.

CHILDE, ARTHUR E., and YOUNG, ARTHUR W. Pneumographic diagnosis of intraventricular epidermoid. *Radiology*, Jan., 1947, 48, 56-60.

Intracranial epidermoids are comparatively rare. The reported incidence is variable but probably less than 1 per cent. Intraventricular epidermoids are even less common but have an unmistakable pneumographic appearance. The authors report a case in which the diagnosis was made preoperatively.

Plain roentgenograms of the skull were non-contributory. The encephalograms suggested a block above the fourth ventricle. Ventriculography showed dilatation of the posterior portions of both lateral ventricles and dilatation of both temporal horns. The anterior portions of both lateral ventricles were enlarged upward and reached to within 1.5 cm. of the inner table of the skull. These portions of the ventricles were almost filled by soft tissue masses through and around which multiple furrows containing gas were visible. The tumor masses did not extend into the posterior horns. The third ventricle was poorly visualized but contained oxygen in its inferior portion. At operation a typical

epidermoid was removed from the lateral and third ventricles.—*John R. Hannan, M.D.*

KING, JOSEPH E. J. Diploic epidermoid and extra-dural pneumatocele: cranial defects and deformity. *Ann. Surg.*, May, 1948, 127, 925-952.

The author presents two unusual types of cranial defects: (1) diploic epidermoids and (2) extradural pneumatocele of spontaneous origin. He supports his statement that preoperative diagnosis can always be made in these cases with clear-cut descriptions of the characteristic roentgen findings in each group.

The diploic epidermoids produce two types of skull defects: (1) Infrequently the tumor will be completely extracranial with erosion of the outer table only producing a doughy tumor which does not pulsate or show an impulse on coughing. (2) In the majority of these neoplasms arising from congenital epidermal rests in the diploe there is destruction of the inner table. The margin of the defect is scalloped, dense and clear cut. Bony hiatuses may be observed in the outer table. It is believed that the density of bone of this margin is due to the compression of the bone by the slowly growing tumor. There is no invasion of the bone. Lesions range in size from 1.5 cm. to 7.5 cm. in diameter or more. Rate of growth is very slow. The treatment of choice is block excision for complete removal unless the underlying dura contains a vital structure such as the lateral sinus when one must be content with curettage and sclerosing solution.

The accumulation of air between the dura and skull without perforation of the skull is a rare condition. The author reports 2 cases. On the skull films the cranial defect gives the impression of "coral rock" with well-defined, finely scalloped margins. Grossly there is irregular erosion of bone which is associated with sharp projections, stalactitic in character. There is no clear explanation for this appearance of bone other than the pressure of the air. For treatment the involved portion of bone should be removed, and the air fistula should be located and sealed off.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

VAN METRE, THOMAS E., JR. Malignant tumors of the nasopharynx. *Bull. Johns Hopkins Hosp.*, Jan., 1948, 82, 42-55.

A review of 46 cases of malignant tumor of

the nasopharynx is given. A rather adequate table giving the clinical picture of all the cases is presented. Other tables showing the type of tumors found, the age of patients involved, classification of the type of first symptoms, interval between first symptoms and hospital admission, and incidence of types of signs and symptoms on admission are also presented. In all cases a visible growth was present in the nasopharynx. The main signs and symptoms were those of pressure, obstruction, and destruction caused by the growth. Roentgenograms of the skull were obtained in 21 of the 46 patients. These were of much value diagnostically, however, in that definite erosion of the base of the skull was shown in 12 cases and soft tissue shadow of tumor displacing the nasopharyngeal air column was demonstrated in 7 instances. In only 7 cases did roentgenograms fail to show evidence of tumor and this was probably due to the fact that anteroposterior, lateral and stereoscopic films of the skull were not taken routinely. Therapy and mortality values are not analyzed, but a table of the significant autopsy findings of 5 cases is included.—*Jerome J. Wiesner, M.D.*

NECK AND CHEST

McCLENDON, J. F., FOSTER, WM. C., and CAVETT, J. W. An attempt to explain the anomalous action of Lugol's solution in exophthalmic goiter. *Endocrinology*, March, 1948, 42, 168-173.

Using chicks as the experimental animal, one group was fed thiouracil, one group Lugol's solution and one group used as controls. The thyroid and pituitary glands were analyzed for protein-bound iodine. Thiouracil markedly increased the weight of the thyroid glands and reduced the protein-bound iodine to 10 per cent of normal. The protein-bound iodine of the pituitary glands was reduced to 85 per cent of its normal value.

Lugol's solution increased the protein-bound iodine of the thyroid 133 per cent and of the pituitary 48 per cent. It seems probable that local action of this protein-bound iodine in the pituitary might inhibit the release of thyrotropin and explain the anomalous action of Lugol's solution in exophthalmic goiter.—*John W. Karr, M.D.*

WYMAN, ALVIN C. Primary atypical pneumonia; roentgenographic course, complications,

recovery rate, and end results. *Dis. of Chest*, July-Aug., 1948, 14, 568-579.

This is a statistical analysis of 855 cases of primary atypical pneumonia of unknown etiology in males, ranging in age from seventeen to thirty-five, at a naval recruit training center. The location of the pneumonia by lobe involvement was correlated with complications such as pleurisy or effusion, reinfection, recurrence, clearing time, and conditions of the lungs at the conclusion of the disease. Seventy-five per cent of the cases involved one or both lower lobes, with almost equal incidence in the other three lobes including multilobar involvement. The roentgenographic clearing time averaged 15.2 days without correlation between lobe involved and recovery rate in uncomplicated cases. About four additional days were required for clearing if pleurisy or effusion complicated the disease. Rare complications include atelectasis, pneumothorax, subcutaneous emphysema and bronchiectasis. Complete recovery was noted in 91 per cent, while 7 per cent showed residual pleural thickening or parenchymal fibrosis. Four cases of lower lobe bronchiectasis were proved by bronchography after reaching the chronic stage, to exclude the possibility of "pseudo-bronchiectasis."—*Fred R. Gilmore, M.D.*

MORGAN, RUSSELL H. The roentgenologic diagnosis of tuberculosis. *Bull. Johns Hopkins Hosp.*, March, 1948, 82, 411-413.

The author states that two comprehensive investigations within recent years have shown that mass roentgenographic methods are as efficient as regular 14 by 17 inch films in the early detection of tuberculosis. In the ensuing discussion it was revealed that as many as 1,000 films can be read adequately in one hour. There is a subjective error in reading these films, however, in that a reader in reading a set of films for the second time may have a discrepancy of 15 per cent between the two readings—the same as the discrepancy between five different readers reading films simultaneously. Distance from the films is a factor in the ability to see the lesions. Where there was a difference of opinion in reading films among several readers, the majority rule was abided by. These roentgen-ray procedures are on sound ground in diagnosing tuberculosis, but the evaluation of the activity of the lesion is more difficult and the margin of error varies accordingly.—*Jerome J. Wiesner, M.D.*

LINCOLN, EDITH M., STONE, SAMUEL, and HOFFMAN, OLGA R. The treatment of miliary tuberculosis with promizole. *Bull. Johns Hopkins Hosp.*, Jan., 1948, 82, 56-75.

In a period of over seventeen years prior to this study 102 cases of miliary tuberculosis in children with roentgen evidence of mottling of the lungs were seen. All of these terminated fatally. In this study 11 cases of miliary tuberculosis which showed mottling of the lungs on the roentgenogram were treated with promizole. Dosage and toxic effects are discussed. Six case histories are given. Of these 11 children, 5 consecutive cases were apparently treated adequately with promizole and of these 2 are dead but 3 are alive thirty to thirty-three months after promizole was first given. Roentgenograms in these all showed recession of the miliary lesions. Also reported is a case of pulmonary miliary tuberculosis which developed in an adolescent girl with chronic hematogenous tuberculosis. Roentgenograms showed complete clearing of the miliary lesions after nine months of promizole therapy. Although promizole acts very slowly in children, it does seem to have a favorable action in suitable cases of miliary tuberculosis.—*Jerome J. Wiesner, M.D.*

LIVINGSTON, SAMUEL. Sedimentation rate in asthma in children. *Bull. Johns Hopkins Hosp.*, March, 1948, 82, 385-388.

In a previous publication the author reported the results of treatment of a group of 34 asthmatic children by irradiation of the lymphoid tissue of the nasopharynx with radon. This group included patients with both intrinsic and extrinsic asthma and all had suffered frequent asthmatic attacks for at least two years prior to treatment. In this study the author reports the erythrocyte sedimentation rate in 33 of the 34 patients before and after treatment with radon. Of 22 patients who responded to the radon treatment (moderately to completely relieved of asthmatic attacks) 21 had a high sedimentation rate before treatment and in all but one of these the sedimentation rate returned to normal after radon therapy was completed. Of the 11 patients who failed to respond to radon treatment only one had an increased sedimentation rate before treatment. It was suggested, therefore, that the sedimentation rate determination is a good test in predicting which children with asthma will be benefited by irradiation and to differentiate between infectious and

non-infectious (allergic) asthma.—*Jerome J. Wiesner, M.D.*

LENÈGRE, J., KILAI DONIS, P., and DE BRUX, J.
Les calcifications de l'aorte ascendante. (Calcifications of the ascending aorta.) *Arch. mal du coeur*. May-June, 1948, pp. 193-210.

Thirty such cases as observed roentgenologically are reported. A routine fluoroscopic examination of the chest is superior to teleroentgenography. Use of more penetrating rays (under 4 to 5 ma.) and a thorough search of the aortic region (in the anterior and oblique, especially anterior left oblique, positions) with a well diaphragmed beam is stressed.

The average age incidence was sixty-one years. Twenty out of the 30 cases had proved syphilis. Of these 20 cases 11 did not show a positive serology at the stage of aortic calcification. The syphilitic calcifications are at the proximal part of the aorta, at the origin of the arch. If found at the horizontal portion they could always be traced to the ascending part of the aorta with a continuous borderline of more than a few centimeters, whereas atheromatous calcifications have a distal topography (usually on the horizontal part of aorta) with a scale-like opacity on the inferior left border of the aortic arch.—*J. N. Sarian, M.D.*

MELAMED, ABRAHAM, and WALKER, LYNN J.
Dissecting (intramural) pharyngo-esophageal diverticulum. *Radiology*, Dec., 1947, 49, 712-716.

The authors present a case report of a dissecting (intramural) pharyngo-esophageal diverticulum of the pulsion type in a fifteen year old boy. The symptoms were present for one month prior to the examination and a surgical excision was performed nine months later.

The roentgen signs of this type of diverticulum are described as follows: (1) opacification and emptying of the diverticulum during examination in the upright position; (2) an apparent elevation or "lifting" of the diverticulum during deglutition, due to expulsion of its contents by the surrounding and contracting esophageal musculature; (3) origin in the midline posteriorly; (4) obscuration or "disappearance" of the opacified diverticulum in the lateral view, due to superimposition of the opaque shadows of the diverticulum and esophagus proper.—*Norman Heilbrun, M.D.*

ABDOMEN

BRUMMER, PEKKA, and BUNDUL, ALFRED. On the effect of some common gastric drugs on the motility of the stomach. *Acta med. Scandinav.*, June, 1948, 130, 559-574.

The authors carried out roentgen examinations to determine the effect of the usual gastric drugs on the motility of the stomach. The drugs used were atropine, sodium barbital, papaverine, hydrochloric acid, and five different antacids. Atropine decreased and sodium barbital increased the gastric peristalsis. Papaverine did not affect gastric motility but decreased duodenal motility and tone. Hydrochloric acid, likewise, had no distinct effect on the gastric motility, while it increased the duodenal peristalsis, causing in particular retroperistalsis. Among the antacids, sodium bicarbonate very clearly increased the gastric peristalsis, which was also true, although in a less marked degree, of the other antacids used; the magnesium salts furthermore acted on the duodenal peristalsis. The authors believe that benefit from the drugs under observation is due to their effect on gastric and duodenal motility. This was further corroborated by therapeutic experiments in which sodium bicarbonate, which had the most distinct effect on the gastric motility, relieved gastric distress of patients distinctly better than other antacids which had equal or greater neutralizing powers. It cannot be said with certainty why one patient prefers one drug and another patient will prefer a different drug. However, the authors feel that further studies in motility will be more revealing than studies of secretion in determining the laws governing these therapeutic effects.—*Charles M. Nice, Jr., M.D.*

FERGUSON, IRA A. Prolapse of the gastric mucosa. *Ann. Surg.*, May, 1948, 127, 879-886.

The author states that prolapse of gastric mucosa through the pylorus is a distinct clinical entity with an incidence greater than that of gastric ulcer. In a review of 297 gastrointestinal examinations this condition was observed in 23 cases, or an incidence of 7.7 per cent. It is seen in males in a ratio of 5:1 and chiefly in the fourth decade although age range was from twenty to eighty years.

Although the etiology is unknown several interesting theories are discussed. One of these is based on low grade inflammation of the mucosa

by chronic irritation with resultant hypertrophy. Another cites the normal mobility of the gastric mucosa and believes that neurogenic factors may be sufficient to cause the prolapse without pre-existing disease.

The pathological changes are redundancy of the gastric mucosa and increased mobility in the prepyloric area. The portion of the mucosa which prolapses is often hyperemic. Ulceration and polyp formation of this mucosa have been reported. As the symptomatology is variable, an exact diagnosis rests on the roentgenographic findings which are distinctive. The author quotes from Pendergrass and Andrews for the roentgen features and includes the following: (1) the prolapsing gastric mucosa produces a central filling defect in the duodenal cap with a thin shadow of barium around the defect; (2) the size of the defect depends on the degree of the prolapse and the motor activity of the stomach and is usually not seen in the erect position; (3) the diagnosis can be easily missed by fluoroscopic examination; (4) there is no disturbance in the passing of the peristaltic waves and the duodenal bulb is not irritable; (5) there is usually a six hour residue; (6) there is a variable defect in the prepyloric region of the stomach when prolapsed mucosa extends through the pyloric ring although the redundant gastric rugae can usually be traced from the antral canal to the base of the duodenal bulb.

The treatment in most cases can be dietary management and antispasmodics but surgical intervention is required in the more advanced cases.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

KIRSNER, JOSEPH B., PALMER, WALTER L., MAIMON, S. N., and RICHTS, W. E. Clinical course of chronic nonspecific ulcerative colitis. *J.A.M.A.*, July 10, 1948, 137, 922-928.

Literature pertaining to nonspecific ulcerative colitis continues to emphasize widely varying concepts as to pathogenesis and treatment. Few observations are recorded as to the natural history of the disease. For the purpose of inquiring into the natural history of this condition 100 out of a total of 250 patients were chosen because of completeness of data, length of period of observation and accurate information as to present status.

Nonspecific ulcerative colitis is a chronic disease whose course is characterized by exacerbations and remissions. This morbid process may

possibly extend by retrograde spread from anus to terminal ileum. It was, however, surprising to note how frequently the initial involvement seemed to be the maximum involvement. Evidence of improvement could usually be obtained by proctoscopic examination.

The roentgen findings did not, as a whole, correlate with the clinical severity of the disease or with the duration of symptoms. By roentgen examination complete involvement of the colon was observed in 10 patients whose illness had existed less than one year, whereas a normal colon was demonstrated in 2 persons more than ten years after the initial appearance of their symptoms. The roentgen report of the colon was normal in 24 of 89 patients studied in this series.

Obviously the cause of nonspecific ulcerative colitis is obscure. Precipitating factors seem predominantly to be associated with emotional stress, acute infection of the respiratory tract and physical fatigue. In this series the number of complications were high. Complications can be divided into two groups: (1) those secondary to loss of nutrition such as cachexia, anemia, fatty degeneration of the liver; and (2) those local in nature such as perforation, abscess, fistula, stricture and neoplasm. Peritonitis secondary to bowel perforation, malnutrition and thrombosis accounted for the majority of deaths.

Lasting cure is rare following medical management comprising 6 per cent in this series. Forty-seven per cent of the patients were, however, maintained in a satisfactory state of health by medical regimen. Surgery restored 14 of 19 patients to satisfactory health. There were 5 deaths among the surgical cases. Ileostomy resulted in no cure. Six of the 9 patients who died under medical supervision died before 1942. The effect of more modern modalities of therapy (nutritional, antibiotic and psychiatric) on the course of this disease remain to be ascertained.—*William E. Howes, M.D.*

PRESENT, ARTHUR J., and GEYMAN, MILTON J. Diffuse calcification of the pancreas. *Radiology*, Jan., 1947, 48, 29-32.

Present and Geyman report 2 cases of diffuse calcification of the pancreas. They state that the literature contains only 17 cases of pancreatic calcification, other than stones. One of their cases occurred in a white male, aged twenty-three, who, for a period of three years, suffered recurrent attacks of epigastric pain with nausea, vom-

iting, and diarrhea. There was a preceding, questionable diagnosis of duodenal ulcer. The urine contained acetone and diacetic acid. Excretory urogram was normal, as was a cholecystogram. At operation, when the distal two-thirds of the pancreas was removed, only small patches of normal pancreatic tissue remained, the major portion of the pancreas being replaced by dense hyaline connective tissue containing numerous cysts and abscesses with multiple calcifications.

The second case was not proved by operation. The chief symptom was vague epigastric pain and the pancreas presented numerous calcifications. In discussing the differential roentgen diagnosis, distribution of the calcifications throughout the usual position of the pancreas is stressed. The authors state that pancreatic calculi are larger and usually confined to the head of the pancreas. Biliary and urinary calculi, calcified nodes, calcification of the costal cartilages, calcifications in the liver and spleen and adrenal calcifications are to be considered in the differential diagnosis. The use of air in the stomach may be helpful in localizing the calcifications.—*Robert C. Pendergrass, M.D.*

GYNECOLOGY AND OBSTETRICS

Howson, John Y. Pelvic cancer delay; organization and observations of the Philadelphia committee for the study of pelvic cancer. *Am. J. Obst. & Gynec.*, March, 1948, 55, 538-540.

A committee of gynecologists has been formed in Philadelphia to study all pelvic cancer cases in Philadelphia with special reference to the sequence of events occurring between the onset of the patient's first symptoms, a definite diagnosis and adequate treatment. The facts obtained from this study are to be used to inform the medical profession of their importance in diminishing the delay in diagnosis of pelvic cancer. The committee meets monthly. Patients investigated during the preceding month are divided into those revealing no delay and those with an apparent delay. Those with an apparent delay are then divided into 3 groups: (1) delay due to the patient, (2) delay due to the physician, and (3) delay due to both. Physicians connected with the patients were invited to the meetings to discuss the cases—otherwise information obtained from the patient alone may be misleading. This also serves another purpose of education of the physician.

Between Nov. 1, 1945 and Jan. 1, 1947 some

455 living patients with pelvic cancer were investigated. Of this number there was no delay in 31.8 per cent and a delay of one or more months from the first symptoms until a correct diagnosis was made and adequate treatment instigated in the remaining 68.1 per cent. Of the cases showing a delay the patient was responsible in 63.6 per cent and the physician in 24.5 per cent. Patient and physician were dilatory in 12.0 per cent. In 82.3 per cent of the cases one physician was responsible for the delay, in 15 per cent two physicians were involved, and in 2.6 per cent three physicians were responsible. It is to be noted that in 113 cases showing physician delay a total of 136 doctors were responsible. These figures demonstrate that the physician plays an active part in the problem of delay in early diagnosis.—*Wendell C. Hall, M.D.*

Scheffey, Lewis C., Rakoff, A. E., and Hoffman, Jacob. An evaluation of the vaginal smear method for the diagnosis of uterine cancer. *Am. J. Obst. & Gynec.*, March, 1948, 55, 453-460.

The authors have had four years' experience covering approximately 5,000 cases with the Papanicolaou technique of diagnosing uterine cancer from the cytology of vaginal smears. Vaginal smears were taken on all patients admitted to the gynecological wards, care being exercised not to take smears within twenty-four hours of a vaginal douche or other procedures which might interfere with the collection of material or staining reaction. The smears were all taken by one trained technician. The technique was that described by Papanicolaou and Traut. The smear from each case was given a number and reported so that the reader of the slide did not know the patient or clinical history. On the other hand, the pathologic diagnosis of removed tissue was submitted by the pathologist without any knowledge on his part of the findings of the cytologist. The study was continued until 500 consecutive cases had been completed.

The vaginal cytology smear is not intended to replace biopsy of the cervix or diagnostic curettage of the fundus, and even in most competent hands some cases of carcinoma will be missed by the vaginal smear method and there will be some false positives. The larger the number of samplings taken from a patient, the more accurate the results, but in the present series only one smear was taken from each patient for practical purposes. This is probably responsible for

the high percentage of positive cases missed in the present series, and since completion of the study the authors now get repeated smears on cases in which any bizarre cells are seen. Unquestionably the experience of the microscopist is of great importance in the success of the vaginal smear method. There is also a personal factor involved since some technicians have an excess of false positives whereas others have an excess of false negatives in their results.

The present study indicates the general value of the vaginal smear technique for routine study of gynecologic patients and the authors feel that this technique may well take its place as a routine public health diagnostic measure. The study emphasizes the importance of fully investigating every case presenting cells suggestive of malignancy, since the percentage of false positives is not high.—*Wendell C. Hall, M.D.*

SKELETAL SYSTEM

OLDFELT, C. O. Renal osteodystrophy; report of a case. I. Clinical aspect. *Acta med. Scandinav.*, May, 1948, 130, 489-499.

The author presents the clinical aspects of a case of renal osteodystrophy in an adult woman who was thirty-three years of age when first seen. There were multiple areas of rarefaction in the bones of the pelvis, some of the long bones, phalanges and vertebrae. There was a strong tendency to calcification in the soft tissues of the abdominal wall, as well as in the arteries of the extremities. The blood calcium was normal, the secretion of calcium in the urine was not increased, and a marked renal insufficiency, with increased non-protein nitrogen and increased blood phosphorus, was present the whole time she was under observation. A history of urinary tract infections, normal blood pressure and urinary findings suggestive of contracted kidney suggested a diagnosis of chronic pyelonephritis. Primary hyperparathyroidism seemed unlikely, as the serum calcium and the secretion of calcium in the urine registered normal values. However, on clinical data it was possible that the case could have been one of primary hyperparathyroidism that came under observation only after advanced renal insufficiency had developed.—*Charles M. Nice, Jr., M.D.*

ENELL, HERBERT. Renal osteodystrophy. II. Pathological-anatomical account. *Acta med. Scandinav.*, May, 1948, 130, 500-504.

This author gives the findings of the post-mortem examination in the same case discussed in part I. There was a fairly homogeneous enlargement of the parathyroid glands, and since there was no pronounced adenoma formation the picture conforms most closely with a diffuse parathyroidal hyperplasia of the secondary type. No postmortem examination of the skull (and therefore of the hypophysis) was made. The kidneys were small and shrivelled, weighing 100 grams, macroscopically presenting the picture of severe nephrosclerosis and small parenchymal cysts. The microscopic picture revealed arteriosclerosis, while the somewhat larger vessels were relatively thin-walled and but slightly sclerotic. In the renal vessels of the size of art. arciformes there were extensive intimal calcifications of the Jores' type. There were also abundant calcifications in other organs of the body, including the endocardium, pleura, mesentery, splenic, femoral, uterine and hemorrhoidal vessels and the skin. The vertebrae presented a microscopic picture of diffuse disintegration of bone, with no signs of formation of new bone.

The pathologist agrees with the clinician that the condition was primarily of renal origin.—*Charles M. Nice, Jr., M.D.*

STEINBROCKER, OTTO, SPITZER, NORMAN, and FRIEDMAN, HAROLD H. The shoulder-hand syndrome. *Ann. Int. Med.*, July, 1948, 29, 22-49.

This condition consists of a peculiar combination of painful shoulder disability with homolateral pain and swelling of the hand in otherwise healthy adults. The emphasis on the unity of the shoulder and hand symptoms conferred by a special term may stimulate more frequent and earlier diagnosis as well as more rational, less strenuous therapeutic measures than have been reported.

The classic concept of reflex neurovascular dystrophy following some form of external violence has been established so firmly by Sudeck's description of post-traumatic osteoporosis that a history of trauma has come to be expected or assumed when trophic symptoms are encountered in an extremity. In medical conditions complicated by reflex dystrophy we are actually confronted with internal irritation or injury as the precipitating factor. It must be concluded, therefore, that the similar clinical pictures seen with the varied etiology consid-

ered here may be produced by either internal or external tissue trauma acting through an identical neurophysiologic mechanism.

A number of seemingly different disorders frequently involving the upper extremity, including the idiopathic shoulder-hand syndrome described in the surgical and medical literature as separate entities appear to be closely related. Although their etiology of precipitating factors varies, these conditions exhibit features which are quite similar and the underlying mechanism seems to be identical, a reflex neurovascular dystrophy. The current neurophysiologic concept of a "vicious circle" mediated through an internuncial pool of active stimuli in the cord provoked and maintained by the primary precipitating conditions explains the mechanism common to all forms of reflex (neurovascular) dystrophy, regardless of etiology. It serves as a useful working basis for the present therapeutic approach.

Treatment by sympathetic interruption (with stellate and upper dorsal ganglion block or surgery) is effective in a great number of all etiologic varieties, in that way confirming the common identity of the underlying mechanism.

An excellent discussion of the clinical and roentgenographic changes seen in this syndrome following myocardial infarction, post-hemiplegic and post-herpetic cases is contained in the original article.—*Eugene J. McDonald, M.D.*

GILBERT, RENE, and VOLUTER, GEORGES. Contribution à l'étude radiologique des modifications osseuses et cutanées concomitantes dans la région des jambes. (Contribution to the roentgen study of concurrent skin and bone changes in the leg.) *Acta radiol.*, 1948, 29, 403-428.

In varicose ulcer, changes in the bone structure and periosteal reactions may be seen in the bones of the leg before cutaneous changes are detectable. The authors have shown that osseous changes in the unaffected leg were noted in cases of varicose veins without ulcer. In their opinion the disorganization of the venous circulation, apparent only on one side, may give rise to osseous changes in the opposite leg (which presents no clinical signs).

They conclude that the varicose syndrome, unilateral in appearance, is in reality a bilateral process in which dystrophic disturbances may involve the skin and other soft tissues without

being recognizable. These alterations may be associated with osseous changes.—*Mary Frances Vastine, M.D.*

HIGHSMITH, LARUE, S., and PHALEN, GEORGE S. Sideswipe fractures. *Arch. Surg.*, May, 1946, 52, 513-522.

The term "sideswipe" is applied to a mutilating fracture of the left elbow, since it denotes the manner in which it was sustained. The driver of an automobile has his left arm resting on the window frame, with his elbow projecting from the window, when his car is sideswiped by an oncoming vehicle or struck by some overhanging projection. Because of the mode of occurrence of this particular fracture, it has also been aptly termed a "car window elbow," a "driver's seat fracture," or a "traffic elbow."

The authors believe that the occurrence of this fracture could be largely prevented if the medical profession as well as the general public could be better informed concerning the manner in which the fracture is sustained. Seven cases are presented and the treatment is discussed in detail.—*James J. McCort, M.D.*

LYFORD, JOHN, III, JOHNSON, ROBERT W., JR., BLACKMAN, SAM, and SCOTT, ROGER B. Pathologic findings in a fatal case of disseminated granuloma inguinale with miliary bone and joint involvement. *Bull. Johns Hopkins Hosp.*, Nov., 1946, 79, 349-357.

The pathologic findings in a fatal case of granuloma inguinale are detailed. The foci infected by the Donovan bodies consist of great numbers of closely packed mononuclear cells which are foamy in appearance and are evidently full of lipoid. The lymph nodes are completely destroyed and replaced by these cells where they grow to form elongated narrow cells which form criss-crossing bundles almost like a fibrous tissue tumor. In the liver, spleen, bone marrow and bronchial lymph nodes there are miliary abscesses which contain some of these cells and other pyknotic necrotic cells and nuclei. The endometrium, fallopian tubes and ovaries are extraordinarily infected and contain myriads of these foamy cells. In sections of tissues stained with Giemsa stain there appear in the cytoplasm of the foamy cells, granular, bluish stained forms corresponding to the Donovan bodies. These findings are a further demonstration that granuloma inguinale is a general systemic disease which does involve bone, joints

soft tissues, internal organs and can terminate fatally.—*James J. McCort, M.D.*

OOSTHUIZEN, S. F., and BARNETSON, JAMES.
Two cases of lipomatosis involving bone.
Brit. J. Radiol., Oct., 1947, 20, 426-432.

Two cases are presented. Each was an adult male with a history of some enlargement of the right foot at birth. One patient was a white European, the other a native South African. Each had progressive enlargement of the foot, and after complete roentgenological and both gross and microscopical pathological examination it was found that each had large deposits of adult type adipose tissue in and about the bony structures of the foot, in some areas replacing or destroying bone. In both there was overgrowth and enlargement of the bones involved with distortion and destruction of some portions of bones and expansion of other areas. Most of the joints had been obliterated by the process and there were large lobulated soft tissue tumors. In both patients there was localization to the foot.

No similar case could be found in the available literature.—*E. F. Lang, M.D.*

SHALLOW, THOMAS A., and WAGNER, FREDERICK B. Pulsating benign giant cell tumors of bone; report of a case and review of the literature. *Arch. Surg.*, June, 1946, 52, 661-676.

A case of pulsating benign giant cell tumor of bone is presented in detail and 6 additional cases from the literature since 1900 are reviewed. The histopathologic picture is indistinguishable from the ordinary variety of giant cell tumor. The pulsation probably depends on free communication of the capillary network of the tumor with its arteriolar and arterial supply,

looseness of the supportive stroma and erosion of the bony cortex.

This tumor must be differentiated from other pulsating tumors of bone, namely telangiectatic osteogenic sarcoma, metastatic carcinoma from the thyroid or kidney, and benign and malignant hemangiomatous tumors.

Treatment should consist in wide surgical resection of involved bone whenever possible. If this procedure is impractical, curettage supplemented by radiation therapy may be employed.—*James J. McCort, M.D.*

McMURRAY, BARRY. A report of six cases of coxa magna following synovitis of the hip joint. *Brit. J. Radiol.*, Nov., 1947, 20, 477-481.

Enlargement of the femoral head occurs in congenital subluxation, pseudocoxalgia, occasionally following suppurative or tuberculous arthritis, and after synovitis. Of the patients in the series, all had suffered a fairly severe infection for at least five weeks; this was followed by a limp. There was enlargement of the corresponding inguinal glands and palpable and periarticular thickening. Because of the prolonged course of the disease and lack of advancing roentgen changes, the diagnosis of tuberculous arthritis was made in each, but later this was questioned because of rapid response to rest. Enlargement of the femoral head began in 2 of the patients within six months of the onset of the disease, and in the other 4 only after ten months. All were discharged from the hospital within eighteen months after admission and were symptom free. Four patients, seen three, four, ten and fourteen years later respectively, were symptom free. Two others, seen six and eight years later, had developing osteoarthritis.—*E. F. Lang, M.D.*





B. R. KIRKLIN
CALDWELL LECTURER, 1948

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 62

AUGUST, 1949

No. 2

GRADUATE EDUCATION IN RADIOLOGY

CALDWELL LECTURE, 1948*

By B. R. KIRKLIN, M.D.

Section on Radiology, Mayo Clinic

ROCHESTER, MINNESOTA

AMONG the pioneer radiologists of America none deserves greater honor than Eugene Wilson Caldwell, and it is fitting that an annual tribute be paid to his memory. To be asked to deliver the Caldwell Lecture is a compliment that I appreciate deeply.

The story of Caldwell's life and work has been told many times before, but for the benefit of those whose recollections do not reach far back into the past, it may be well to recount some of the notable facts in his fine career.

Caldwell, who was born in Missouri in 1870, spent his childhood in Kansas. He entered the University of Kansas at seventeen years of age, and was graduated in electrical engineering in 1892. Shortly afterward he went to New York and became associated with the telephone company of that city. In 1898, only three years after Röntgen's discovery, Caldwell bought some simple roentgen-ray apparatus from a photographer who had found it disappointing as a source of income. From that time on Caldwell was to be a radiologist. His first application of his newly acquired equipment was as an aid to medical diag-

nosis and he foresaw that medicine was to be the chief field of roentgen rays. Accordingly he took a special course in anatomy, and this was followed later by a complete medical course and graduation from Columbia University and Bellevue Hospital Medical College.

Caldwell used his engineering genius and invented or designed and built much of his roentgenologic equipment, including a stereofluoroscope, a tilt table, improved types of roentgen-ray tubes and a self-regulating valve tube. He published one of the earliest papers on the roentgenologic examination of the nasal accessory sinuses and was co-author with William Allen Pusey of a book, "Roentgen Rays in Therapeutics and Diagnosis."

Appointments came to him freely, among them: director of the Edward N. Gibbs Memorial X-Ray Laboratory, visiting physician to several New York hospitals and, during World War I, major in the Medical Reserve Corps. In 1918, at the height of his renown, Eugene Caldwell, the engineer, inventor, physician and pioneer, died as a result of radiation injuries sustained in earlier years when he, like many of his

* Delivered before the Forty-ninth Annual Meeting of the American Roentgen Ray Society, Chicago, Illinois, September 14-17, 1948.

colleagues, was unaware that roentgen rays were potent, not only for good, but also for harm. In his passing the radiologic world suffered a grievous loss, a loss that was not compensated for even by the substantial legacy of advances that he left to his profession.

If Caldwell were living today he would be keenly interested in the professional education and training of radiologists, for every physician who is conscious of his obligations to the public would like his prospective associates and successors to be even more competent than himself. During most of his career, Caldwell had to acquire his knowledge of roentgen rays the hard way; that is to say, he learned chiefly by personal observation and by trial and error, for he was helping to develop a new science and art. True, he was able to pick up bits of information by visits to co-workers, by reading the scant literature and, later on, by attending meetings of small radiologic societies. But for several years roentgenology was not regarded too seriously, and what was known about it could be told quickly, for its principal use was to reveal fractures, dislocations and foreign bodies and hospital orderlies commonly acted as technicians and diagnosticians. Indeed, during the early years it was uncertain whether roentgenology was to become a trade or a profession, for it was practiced by artisans of various sorts as well as by the few physicians who sensed its possibilities.

Well after the turn of the century medical schools began to provide formal, though limited, undergraduate instruction in radiology, not as an independent field, but as a novel yet minor aid to clinical medicine. In the decade 1910 through 1919, however, advances in the diagnosis of pulmonary and gastrointestinal diseases and in radiotherapy, together with striking improvements in apparatus, increased the scope, importance and dignity of radiology so greatly that many of the medical colleges instituted organized courses of graduate training in the new specialty which now ranked with other recognized specialties.

At that time and for many years after, the competence of most specialists varied widely, for each practitioner was the sole judge of his preparation and qualifications. In 1916 the ophthalmologists organized the American Board of Ophthalmology and empowered it to examine and determine the ability of candidates who sought its certificate of competence. This example was not followed by other specialists until eight years later, when the otolaryngologists established an examining and certifying board. Again there was a lull until 1930 when the process of setting up specialty boards was resumed at a rapid rate. In 1934 the American Board of Radiology was formed. In that year also the Advisory Board for Medical Specialties was instituted to advise existing specialty boards as well as groups which proposed the formation of additional boards and all those interested in graduate medical education as related to specialization. Today there are sixteen specialty boards. Their power is by no means absolute, for they heed recommendations of the Advisory Board and, in certain respects those of the Council on Medical Education and Hospitals of the American Medical Association.

It should be understood that the boards derive their prerogatives from the organized practitioners of the respective specialties and exercise limited and revocable privileges within those groups only; that the boards have neither the will nor the power to prevent the practice of any specialty by any licensed physician, regardless of his ability or lack of it; that the main purpose of the boards is to raise the standards of special practice, and that they seek to accomplish this, not by commands, but by offering a certificate of competence to all practitioners who can meet the minimal requirements and pass their examinations.

The boards have been composed of honest, fearless and conscientious men who have given freely of their time in an effort to raise the standards of their specialty without self-aggrandizement. All boards have attempted to set up their organiza-

tions in such manner as to prevent politically minded, selfish persons or groups from gaining control. If any such group ever becomes selfishly dominant, the board affected will cease to perform its proper functions.

It is obvious that specialization is a normal step in the evolution of medicine and has been largely responsible for its recent tremendous progress. It is equally obvious also that specialization has given rise to new and perplexing problems by its impact on practically every field and function of medicine. Apparently medical science, once a homogeneous unit, has disintegrated into a heterogeneous aggregation of more or less independent medical sciences and the medical sages and elder statesmen are already planning ways and means by which this seeming process of disintegration can be stopped and medicine reintegrated into a coherent and coordinated whole. We may confidently assure ourselves that all these disturbances are either purely functional or without grave organic cause, that they are natural in the sense that they are incidental to rapid growth, and that eventually they will be adjusted or will vanish of themselves.

Specialization has also profoundly affected graduate medical education. With sixteen specialty boards asking for sixteen different graduate training programs designed to fit the varied needs of all aspirants for certification, and with the medical schools overcrowded, the teaching staffs of these institutions have many difficult problems to solve. Most of these problems are outside the scope of my theme, for I shall deal only with those related to the present training program for prospective radiologists. I have chosen this subject because our program is neither perfect nor permanent but subject to change as increasing knowledge and experience warrant, and any such change can be brought about only with the advice and consent of the organized radiologists of America, including those here present, and the subject is worthy of our most productive thought, for we earnestly wish that our specialty shall rise to new

heights of human service. As a basis for our considerations the requirements and recommendations set forth by the American Board of Radiology will serve excellently. In brief, the principal items are as follows:

The student in radiology must have been graduated from a medical school recognized by the Council on Medical Education and Hospitals of the American Medical Association and the American Board of Radiology and he must have completed an internship of not less than one year in a hospital approved by the Council. He must have three years of special training in radiology in clinics, hospitals or dispensaries approved by the Board and the Council as competent to give such training. During this period he shall be given graduate instruction in pathology, radiation physics and biology. Six months' full-time instruction in pathology is recommended.

The need for graduate instruction in certain of the basic sciences in the training of a prospective radiologist is obvious. There was a time when roentgen diagnosis and treatment were almost purely empirical and without any substantial underlying rationale, but today the radiologist must know the anatomic-pathologic basis of the shadows and shadow-defects that he sees, and he must have a keen comprehension of pathologic anatomy, radiobiology and radiation physics in order to devise appropriate and efficient therapeutic techniques. It is true that he is taught pathology in the early years of his undergraduate course, but the instruction is general, as it should be, and not fully remembered after graduation. What the student wants now is not only to refresh his memory of pathology in general but also to study it in its specific relationship to radiology. To most graduate students radiation physics and radiobiology will be new but deeply interesting sciences and especially valuable because of their direct and intimate relationship to radiology. These two branches also will be concerned with the broad field that has been opened by the new radioactive isotopes.

Wisely, I think, the Board has recom-

mended that six months of the three-year course be devoted exclusively to pathology. The Board does not insist on this specification, for in some institutions the department of pathology is not prepared to give six months of full-time training to all the residents in the institution, but their students can acquire a reasonable knowledge of the subject by attending all necropsies and pathologic conferences throughout their three-year residency. Training in radiation physics and radiobiology can be done satisfactorily by formal lectures and demonstrations at any time during the residency, although I feel that in the main, didactic teaching should be avoided. Not long ago I heard a renowned teacher of medicine express doubt as to the wisdom or necessity of teaching the basic sciences formally and methodically. He was strongly of the opinion that the student should "follow the rabbit"; that if, in a specific instance, he needed further information concerning a related basic science, he should have enough initiative to look up the facts in appropriate texts or should be stimulated by his instructor to do so. I agree in principle with this wise and revered teacher, but I doubt that the plan is generally applicable at present. It assumes that most students are ardent and most teachers inspiring, an ideal to be wished for and worked for but scarcely existent today. In the meantime it is to be hoped that "spoon-feeding" with formalized lectures will be held to a minimum and that a maximum of the "case system" of teaching will be applied.

Since World War II several medical schools and graduate schools have inaugurated courses in the basic sciences of six to eight months' duration. These courses were mostly didactic in nature and were conceived primarily to assist in providing training in the basic sciences for the large number of young men who were returning from military service. These courses filled a very important need by making it possible for these young men to obtain training in the basic sciences. But now that the emergency is over it is my own opinion that

training in the basic sciences should and can best be given concurrently with the residency training and that wherever possible it should be given by or at the institution responsible for the residency program. Furthermore, I agree with the recent action of the American Board of Radiology whereby it will allow a maximal credit of only six months for any course or residency in the basic sciences, with the result that the student must receive a minimal training of two and one-half years in clinical radiology.

This brings us to the next requirement, which pertains to the thirty months of training in clinical radiology. The Board recommends that the student shall have active experience during this period of his training but, quite properly, it imposes no additional requirements, recommendations or even suggestions as to the division of this period among the various aspects of diagnosis and treatment or the manner in which instruction shall be given. The different institutions, unhampered by any set pattern, are free to use their differing facilities to the best advantage of the student.

In view of the opportunity offered to speak freely I want to voice some of my own ideas about the training of radiologists. At the present time the American Board of Radiology not only lends its approval to departments of radiology for the full three years of training, but also in many cases it recommends approval of certain institutions for training periods of one or two years in one or more fields of radiology. I believe that the Board should indicate specifically the phase of training for which each of these latter institutions is approved, that is, the first, second or third year. I am convinced that wherever possible the student should receive all his training at one institution or, at least, under the direction of one institution instead of dividing his three years into two or more periods in a like number of places. I am sure that the records of the American Board of Radiology indicate that those students who do spend their full three years in one place

make a much better showing than those who divide their training between two or more places.

Assuming that the resident is receiving his training in one of the institutions where the volume of work allows sufficient space, equipment and personnel to provide the ideal type of training, I believe that the three-year training program in radiology should be divided into four major periods: (1) one year in diagnostic roentgenology; (2) one year in therapeutic radiology; (3) a six-month assignment of full time in pathology, and (4) the remaining six months to be devoted to either diagnosis or therapy as the student's interests may dictate. The foregoing fulfills the minimal requirements of the American Board of Radiology and, if the student is of average intelligence, should prepare him to pass their examination.

I have found it advantageous to start the new student in one of the clinical phases of radiology and allow him to continue this phase for at least one quarter. This serves a twofold purpose: first, it allows the radiologic staff to become acquainted with him and to learn something of his interests, personality and ability, and second, it allows the student an opportunity to obtain a superficial bird's-eye view of radiology which may be of some help to him during his assignment to pathology. I also believe it is best that he receive his training in pathology fairly early in his residency. While assigned to pathology, preferably pathologic anatomy, he should be encouraged to pursue some subject of radiopathologic interest. Frequently such an effort will result in a fine piece of work suitable for a thesis which can be submitted as partial fulfillment of the requirements for an advanced degree. I realize that in small institutions it is not possible to assign all residents to six months of full time in pathology but I am sure that fairly satisfactory training in pathology can be obtained if the student is urged or even required to attend all necropsies and clinico-pathologic conferences throughout his residency.

Whether the student is assigned to diagnostic roentgenology or therapeutic radiology next is of little, if any, importance. I have felt that during his service in therapeutic radiology it might be an advantage to be able to understand the roentgenograms that accompany patients who are referred for treatment, and roentgenograms that are inevitably presented in conferences which concern patients who are being treated. For that reason our students first are assigned for three months to the diagnostic section after which, if possible, they go to pathology, then to therapeutic radiology for one year and then back to diagnostic roentgenology for nine months, thereby completing the required service of one year in diagnostic roentgenology. Residents are allowed to spend the remaining six months in either diagnostic roentgenology or therapeutic radiology, whichever is preferred.

All large departments of radiology should have a radiation physicist on their staffs. Small institutions should pool their interests with similar institutions located near by and engage a competent radiation physicist to give an intensive course to their residents. It is imperative that residents in radiology receive adequate instruction in this subject. I am willing to concede that this subject can be taught satisfactorily by formal lectures, if augmented by practical demonstrations. In my institution the radiation physicist divides his instruction into three periods. During the first year approximately eighty hours of lectures and demonstrations are given. These include instruction in all phases of radiation physics. During the second year the resident is required to devote twenty to thirty hours to the calibration of machines, dosage calculations, etc. This can be done best while the student is assigned to therapeutic radiology. During the third year ten to fifteen hours of review lectures and quiz conferences are conducted.

In this connection it is noteworthy that the division of radiology into two independent specialties, diagnostic roentgenology and therapeutic radiology, is being ad-

vocated. This may occur eventually, for it is a normal, evolutionary and progressive step. At this time, however, I feel strongly that complete separation would be premature and not in the best interests of any party concerned. I will qualify this assertion with the admission that in large institutions the sections on diagnosis and therapy may well be separated physically and without interchange of personnel. But for administrative purposes both or all the sections should be under the guidance of a chairman or director, be he a diagnostician or therapist, who does not need to concern himself with the professional work of any section other than the one in which he is actively engaged. The director also should be responsible for the training program, which should continue to provide instruction in all phases of radiology, including the radioactive isotopes. This unity in training still is desirable for all new radiologists and indispensable for those who associate themselves with small groups or hospitals or engage in individual practice; in all of which situations the complete division of radiology is now impracticable.

Likewise in the larger institutions, further specialization within the fields of radiology by the teaching staff is of advantage not only to the patients whom they serve but also to the young men whom they train. In such institutions it is natural that each member of the teaching staff should seek to excel in some one phase of radiology within the field of diagnosis or therapy. I have always encouraged this practice among my own colleagues and am of the opinion that it should be encouraged generally, as it undoubtedly results in better routine work and more efficient training.

It is important to note that while the Board carefully refrains from prescribing methods of instruction, it does say that the student shall have "an active experience," by means of a residency during his two and one-half years of clinical training. The word "experience," used wisely, I think, implies actual participation in radiologic work, with a minimum of lectures

like those with which he was surfeited during his undergraduate course. It implies that as the student progressively acquires the ability to execute individual details of diagnosis or therapy he shall be entrusted with those details and eventually shall be given tentative and closely supervised responsibility for the diagnosis or treatment of patients assigned to him. So valuable is this sort of experience that superior students should, if possible, be given an opportunity to serve temporarily on the staff of the department as first assistants for at least six months, or preferably a year, after completion of a three-year residency. Several of our residents after having served in this capacity, have told me that they considered this extra year to be the most valuable period of their entire training.

Occasionally a student becomes intensely interested in some single phase of radiology. For example, during the past year one of the residents under my supervision asked permission to be assigned for three months to neurologic pathology and another requested six months' assignment to radioactive isotopes. Both requests were granted but the time spent on these assignments will not be credited as a part of the required three-year residency but as additional training time. A student may, during his second or third year, decide that he wishes to devote his full time to either diagnostic roentgenology or therapeutic radiology. I recently had occasion to counsel one of our residents who had elected to limit his practice to therapeutic radiology. I advised this young man to take the minimum of training in diagnostic roentgenology and to devote the remainder of his allotted time in clinical radiology to therapeutic radiology. In addition, I advised him to request an extension of his residency for another year, during which time he should ask for training in allied clinical and surgical fields, such as gynecology, urology, etc.

I am told, unofficially, that there are now one or two large institutions in this country that have added a fourth year to their residency in radiology. Whether the additional year in these instances is compulsory

or elective, I do not know, but if it is the latter I hasten to congratulate them for the reasons which I have mentioned.

For many years it has been my practice to schedule a minimum of formal lectures and a maximum of semiformal seminars and informal conferences. The latter have proved to be efficacious and acceptable methods of instruction. Commonly the seminars, held weekly except during the summer, are devoted to a single subject which has been assigned to and prepared by one of the students serving the second or third year of his residency. He may prepare a paper although he is not allowed to read it, but must present his discussion from notes and lantern slides. Members of the staff attend and participate in the discussions and questions put to the resident who conducts the seminar. Subjects which deal with both diagnosis and treatment are presented during the year and at times residents or staff members from related clinical and surgical fields are invited to conduct one or more of the weekly seminars.

As mentioned previously, many informal conferences are held. These conferences are attended by the residents and staff members of one of the sections; for example, the Section on Therapeutic Radiology conducts what Dr. Leddy calls "the Friday night informal, unceremonious gathering" of all residents assigned to therapeutic radiology as well as the staff members of the section. These meetings are held at the home of one of the residents. Two or more subjects related to therapeutic radiology are discussed freely and informally during which time many provocative questions are asked. Similarly, in the diagnostic section informal conferences are held once or twice weekly and they deal with interesting cases encountered, and are based on roentgenograms and other data selected from material considered at film-reading periods during the day. To these data may be added the clinical history and findings at operation or necropsy. Discussion is informal and usually thorough. Residents are also encouraged to write papers on

radiologic subjects to be presented and discussed at extra seminars or, occasionally, at the general staff meetings of the institution. The preparation of papers is a valuable method of self-instruction, for the writer invariably learns much from his effort whether his audience is edified or not.

Our residents, during their assignment to the diagnostic section, are expected to attend all film readings and are encouraged to discuss or even question the diagnosis or opinion rendered by the staff member. This not only serves to keep the students alert but also the staff members as well. Another important adjunct to informal teaching is a common loafing room in the department where the residents and staff members may gather during their idle moments and discuss the many problems that plague our world today. Invariably, within a few minutes after a member of the teaching staff joins the group, a subject concerning radiology or some allied field will come up for discussion or argument. Usually both the staff members and the students assembled benefit by such informal debates.

Throughout his residency the student should constantly refresh and extend his knowledge of clinical medicine in general, for he is preparing himself to be not merely a specialist but a medical consultant with a primary, but not exclusive, interest in radiology. As such he will often be required to confer with his colleagues in other fields and he should be able to contribute intelligently to the complete correlation of all the data in any case at hand. Certainly radiologists, with their domain overlapping almost every other field, should be the last to furnish justification for the sarcastic witticism that a specialist is one who knows more and more about less and less. In my institution, like all large and many small ones, weekly teaching conferences are held in the various medical and surgical sections. These conferences are open to the staff and residents of that and related sections. An example is the weekly diagnostic chest conference conducted by the medical chest service but the thoracic

surgeons, radiologists, pathologists, bronchoscopists and their residents are permitted to attend. Similar conferences of interest to residents in radiology are conducted by the sections on gastroenterology, urology, neurology, pediatrics, etc. In addition, weekly clinicopathologic conferences and staff meetings are held which are open to the entire staff and residents of the institution. I realize that it is impossible for a resident or anyone else connected with a large teaching medical organization to attend all the meetings, seminars and conferences that are scheduled but by attending as many of these extraradiologic conferences as possible the future radiologist will broaden his knowledge of medicine and surgery and thereby be a better radiologists.

Today there is no paucity of applicants for graduate training in radiology. In most institutions there are from five to twenty applicants for each appointment. Therefore, extreme care should be exercised in the selection of students and only the most promising should be accepted. It is not always an easy task to select the most promising student, for there are several factors to be considered. First among these I would place the student's ability as indicated by his grades in academic and medical schools and by his ability to apply what he knows. It is difficult to determine exactly what scholastic standing one should demand of a prospective resident, but I always feel safe if he ranks in the upper third of his class in medical school. It has been said that the average intelligence quotient of our population is 100, and it is estimated that those in the upper third of their medical class have an average intelligence quotient of 125 to 135, which places them in the upper 5 per cent of the intelligence level of the population. I would next consider the interest or drive of the prospective student. Why is he interested in radiology and what are his aims after completion of his training? Last, I would check carefully

his personal characteristics, such as his ability to get along and work with his fellow man, his personal habits, intellectual honesty, etc. Although a personal interview with the applicant is often of great help, much of the information in regard to his personal characteristics must be obtained from personal references that he furnishes and are known to me. If all of us will exercise extreme care in the selection of those whom we are to train, I am sure we need not worry about the future of radiology.

These are some of the facts learned and some of the opinions formed by one man from many years of experience as a teacher of radiology and member of the American Board of Radiology. Even so, nothing said here can be considered authoritative, for neither medicine nor any of its divisions recognizes any authority except a broad consensus of its practitioners. It would be folly for me or anyone else to attempt to lay down a pattern of graduate instruction in radiology that would be applicable to all institutions, whether large or small. Even in the large institutions the method and sequence of instruction might vary considerably without making the training any the less effective. Furthermore, I wish to declare emphatically that neither the size of the department of radiology nor of the institution which it serves can be taken as an index by which to measure the quality of training. Some of the best training I know is given in departments of radiology with a teaching staff of one man. In such cases the chief is usually a strong, dynamic character who has the ability to inspire his students.

In view of what Eugene Caldwell was able to accomplish without benefit of planned training or guidance, what a grand opportunity for advancement and service is presented to the young student of radiology today!

Mayo Clinic
Rochester, Minn.

CONGENITAL OBSTRUCTIONS OF THE RESPIRATORY TRACT*

I. TRACHEAL MALFORMATIONS

By WILLIAM A. EVANS, JR., M.D.

DETROIT, MICHIGAN

NOISY breathing observed in infants by their mothers or pediatricians is a common indication for roentgenologic studies. It seems normal or at least usual for infants to make some noise in breathing on occasion. When this becomes abnormal in character and an indication of respiratory obstruction is often a point requiring careful and experienced judgment. The frequent association of obstruction of various types in the pharynx, larynx, trachea and bronchi with respiratory infections is generally appreciated. In the past the role of the thymus in producing respiratory obstruction in infants has been emphasized and perhaps in some instances overemphasized. Recently attention has been called to vascular malformations which may produce compression of the trachea. It is the experience in this hospital that anomalies of the great vessels, even when vascular rings are present around the trachea and esophagus, usually do not produce significant compression or narrowing of these structures. Abnormal masses of various types in the neck or mediastinum may produce a similar compression and obstruction. Two factors are present to influence the degree of obstruction—the extrinsic force and the ability of the trachea or bronchi to resist compression. Sgalitzer¹² has emphasized this consideration in adults and it would appear to have a particular applicability to infants in determining the obstructive effects of anomalies of the great vessels, abnormal cervical and mediastinal masses, and the large thymus. It is the purpose of this communication to consider intrinsic fac-

tors of the trachea causing respiratory obstruction in infancy either alone or in combination with extrinsic factors.

CASE I. R. D. This infant was admitted to the hospital at the age of two months with the history of heavy breathing and cough since birth. A brother had died of cystic fibrosis of the pancreas and that diagnosis was made in this case. A narrow air passage in the trachea was observed and the possibilities of a congenital stenosis or a reduction in the airway by thick mucus along the tracheal wall were entertained (Fig. 1). The infant died at ten weeks of age and a cystic fibrosis of the pancreas was found and also a very narrow trachea. An indentation was seen along the anterior surface corresponding with a ridge or spine projecting into the lumen which gave off the cartilaginous rings like asymmetrically placed ribs.

CASE II. S. O. This infant was born in February, 1944, and was first seen at three weeks of age with the story that he had had a cold, cough and nasal discharge since birth. At one month he was observed to be in respiratory distress and there was thought to be difficulty in the passage of air through the trachea. During the next three years there were eleven admissions to the hospital for severe respiratory distress precipitated by relatively mild respiratory infections. Bronchoscopic studies were not conclusive and adrenalin was without effect. Lipiodol studies of the tracheobronchial tree at two years eight months of age demonstrated a narrowing of the trachea above the bifurcation and an anomalous origin of the right upper lobe bronchus (Fig. 2). This is also shown in the autopsy photographs. The bronchi were of larger caliber than the lower trachea and the cartilaginous rings in the trachea were found to encircle the trachea completely with an absence of the usual membranous portion in the

* From the Children's Hospital of Michigan, Detroit, Michigan. Presented in part at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

posterior third of the tracheal wall. A cleared specimen of the opened trachea further shows an irregular formation of the tracheal cartilages above the bifurcation. There was no cardiovascular abnormality and the thymus weighed only 7.5 gm.

Atresia of the trachea is extremely rare and is of course incompatible with life.

out so that only esophageal remnants are found in the dorsal tracheal wall.

Congenital stenosis of the trachea usually with a malformation of the tracheal cartilages is also considered a rare anomaly. Montandon⁹ reported a case in 1944 and reviewed 11 cases previously reported in the European literature. In his case there

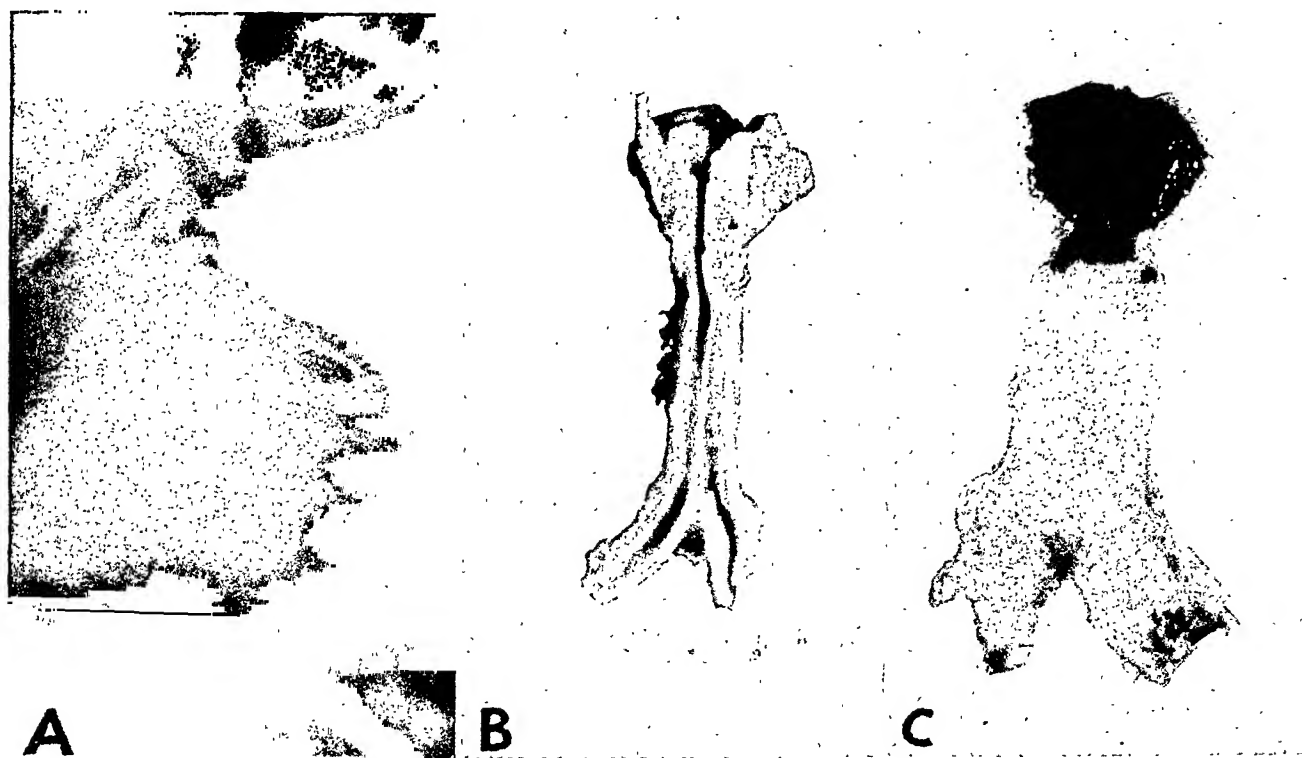


FIG. 1. Case 1. *A*, marked narrowing of the air passage of the thoracic portion of the trachea in its antero-posterior diameter observed in two month old infant with dyspnea and cough since birth. *B*, postmortem specimen of trachea opened posteriorly showing the narrow tracheal lumen and a ridge projecting from anterior surface. *C*, trachea after clearing in glycerin, opened and flattened between glass slides showing bizarre formation of tracheal and bronchial cartilages.

Marek⁸ in 1940 reported such a case and quoted similar cases reported by Fritz (1933) and Payne (1900). In Marek's case the trachea ended as a blind sac just below the larynx. The esophagus was normal except that 3 cm. above the diaphragm there was a small orifice opening into both main bronchi. The much more common tracheo-esophageal malformation is esophageal atresia with tracheo-esophageal fistula. Gruenwald² explains this by the theory that the tracheal segment grows more rapidly than the esophagus and than when there is an incomplete tracheo-esophageal differentiation the esophageal segment is drawn

was a tracheal stenosis 1 cm. below the vocal cords requiring tracheotomy at eleven years of age. The diameter of the stenotic area measured 6 mm. compared with a measurement of 16 mm. in the lower normal portion of the trachea. Only 4 of the reported cases survived infancy. The stenosis may be generalized (Sankott,¹⁰ Wolman¹³), or localized (Haardt,⁴ Montandon⁹). It may be associated with complete cartilaginous tracheal rings (Sankott,¹⁰ Gabriel and Feyrter,¹ Scheid,¹¹ Wolman¹³), or with hypoplasia of the tracheal cartilages (Guisez³). Variations may occur in the situation, number and disposition of the

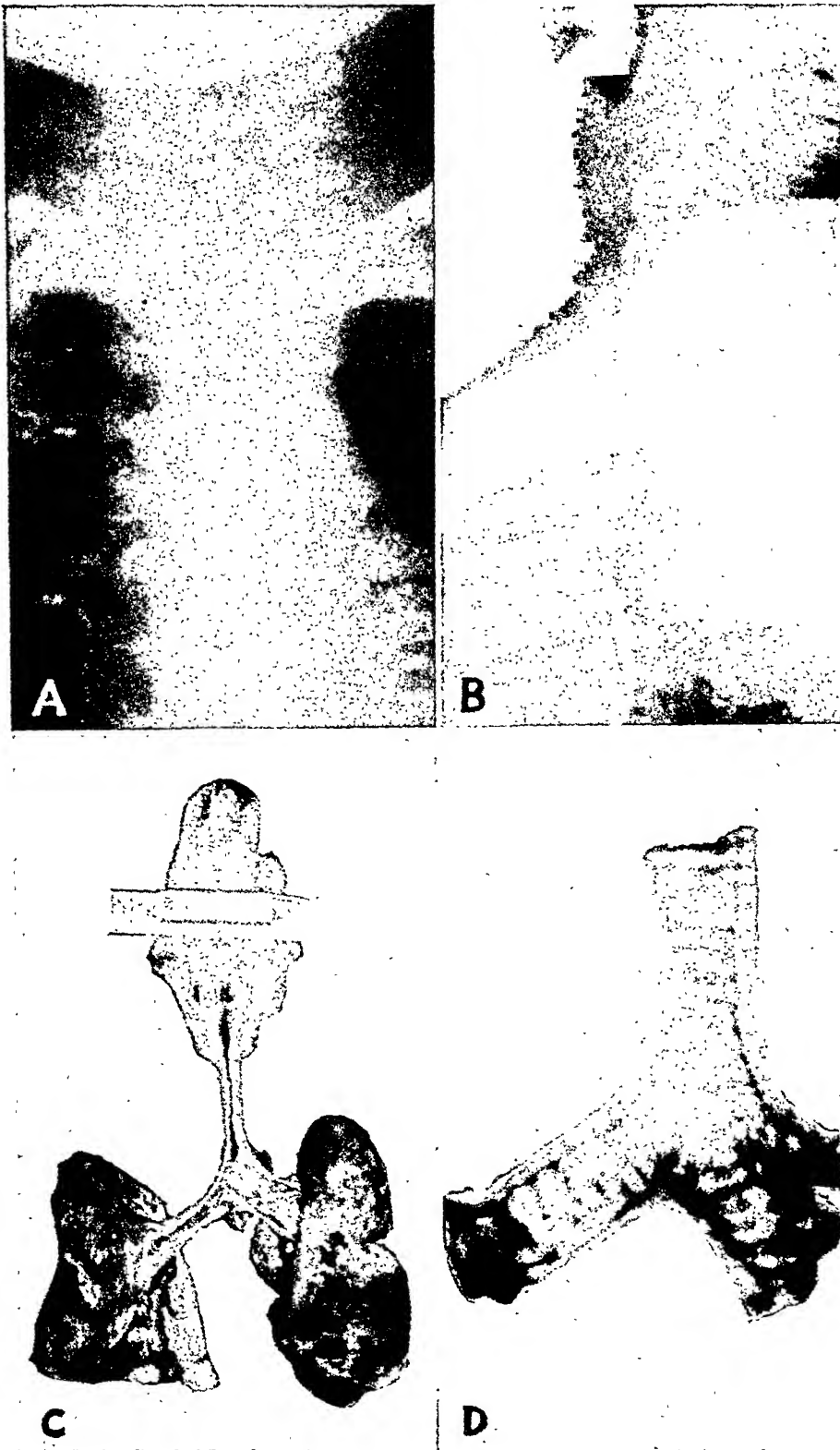


FIG. 2. Case 11. *A* and *B*, anteroposterior and lateral views of the trachea in a two year eight month old infant who had suffered repeated attacks of severe dyspnea, precipitated by mild respiratory infections. The tracheal lumen is narrow particularly above the bifurcation and there is an anomalous origin of the bronchus to the right upper lobe. *C*, postmortem specimens of trachea and bronchi opened posteriorly showing the lumen of the trachea smaller than that of the bronchi. *D*, cleared and pressed tracheobronchial tree. The tracheal rings completely encircle the trachea. The rings are irregular and there is narrowing of the tracheal lumen particularly above the bifurcation. The anomalous origin of the right upper lobe bronchus is again demonstrated.

cartilaginous rings without stenosis (Gabriel and Feyrter⁷) and it is of interest that closed tracheal rings normally occur in most birds, in a few reptiles, and in some apes and humans (Sankott¹⁰). The narrow trachea was visualized roentgenographically in the cases of Haardt⁴ and Wolman.¹³

These 2 cases reported above were seen in the Children's Hospital of Michigan in the same year and 3 similar cases have been seen, 1 of which died without autopsy and

genograms of the infant chest (Fig. 3). Usually there is very little or no alteration in the caliber of the infantile trachea during respiration but it is not uncommon to observe variable degrees of narrowing of the trachea in its anteroposterior diameter if the exposure is made in a phase of expiration (Fig. 4). The variable behavior of the trachea in infants suggests a variable rigidity of the tracheal cartilages which would tend to disappear as the tracheal

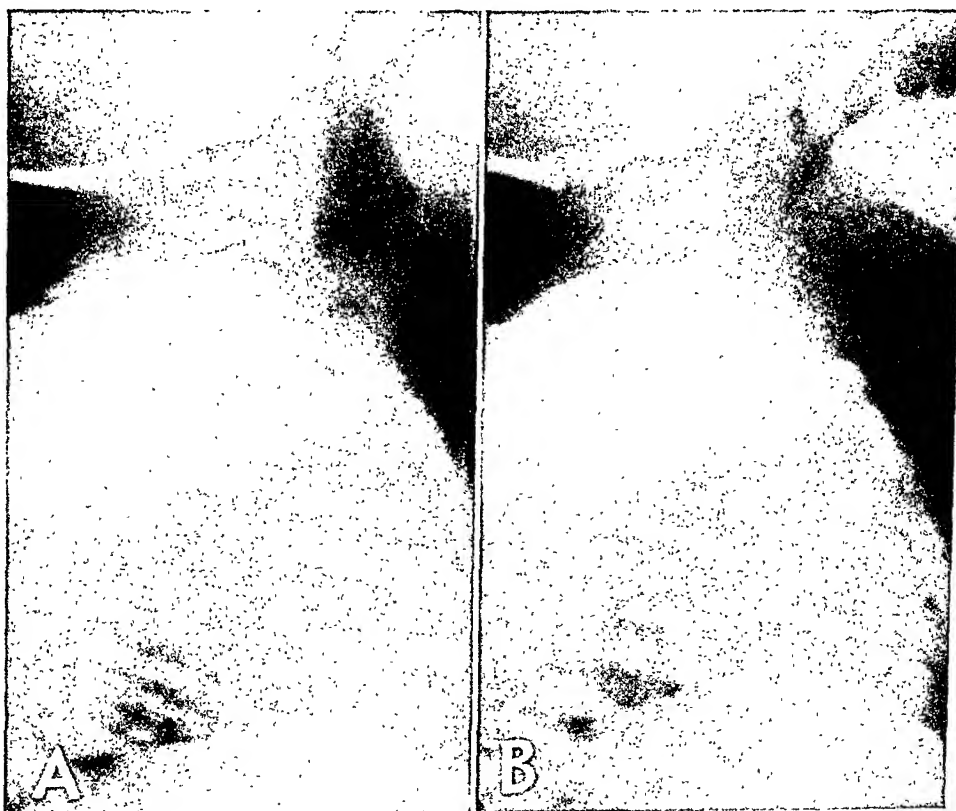


FIG. 3. Appearance of the normal infantile trachea at five weeks of age. Exposures made in inspiration (A) and expiration (B) demonstrate a constant caliber of the air passage in the trachea.

2 are still living, therefore without pathological proof of the diagnosis.

Perhaps this condition would not be regarded as extremely rare if the trachea were examined more carefully in routine roentgen studies of the infantile chest and if the pathological picture were not overshadowed by the complicating respiratory infection which would seem to be the common precipitating cause of death.

It is usually possible to obtain a satisfactory visualization of the air passages in the pharynx and trachea in lateral roent-

genograms of the infant chest. The common observation of buckling of the infantile trachea at the cervical thoracic junction is another indication of the softness and pliability of the infantile trachea. Thus the single observation of a narrow trachea is not sufficient evidence for a diagnosis of tracheal stenosis.

Transient narrowing of the trachea in serial studies is occasionally observed. The studies in Figure 5 are from a two to three weeks old infant with wheezing spells and a harsh non-productive cough. There was

a right upper lobe bronchopneumonia with an uneventful recovery.

We have considered, as possible explanations for transient narrowing of the trachea, spasm which seems unlikely in view of the paucity of muscular tissue in the tracheal wall, mucus overlying the tracheal mucosa, and soft tracheal car-

adjacent trachea was narrowed in its anteroposterior diameter.

Narrowing of the trachea may be seen as the result of pressure anteriorly by a large thymus. The studies in Figure 7 are from a patient who was examined at six weeks of age for noisy breathing, cough and nasal discharge. The large thymus and

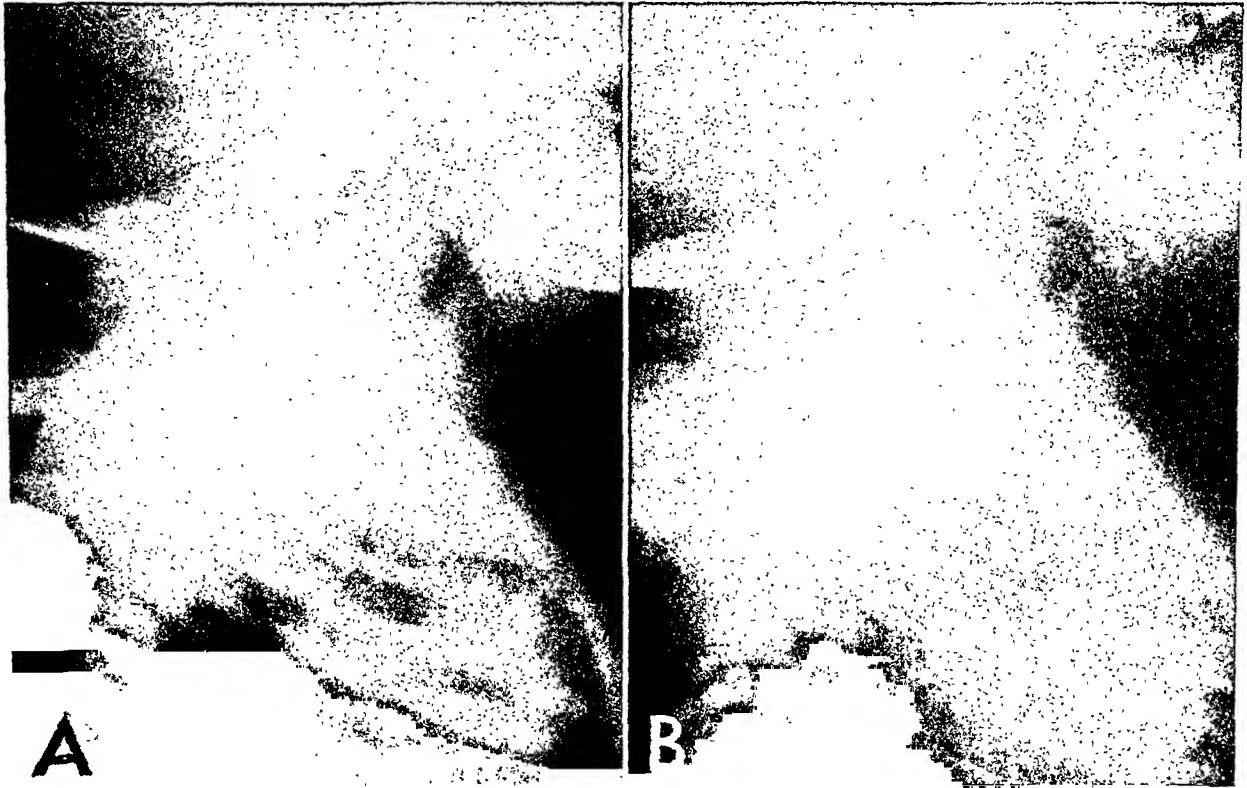


FIG. 4, *A* and *B*. Appearance of a normal infantile trachea at five weeks of age demonstrating a slight variation in the caliber of the air passage in the thoracic portion of the trachea at different periods in the respiratory cycle.

tilages. This latter possibility seems the most probable explanation in most instances.

Transient tracheal narrowing may also occur where external influences are in evidence, probably in addition to soft tracheal rings. The studies in Figure 6 are from an infant who had a tracheo-esophageal fistula which was repaired. The upper esophageal segment was much larger than the lower and there was some postoperative stenosis at the site of anastomosis. In this situation the upper segment tended to dilate with gas or food and when this occurred the

narrow trachea were recognized but little significance was attached to this observation by the clinicians. Noisy breathing was again noted at two subsequent visits and at six months of age the baby was brought back with a very noisy rattling respiration which was aggravated by an upper respiratory infection. The mother gave the story that the baby's respirations were never quiet and became much more noisy with the appearance of a "cold." The large thymus and narrow trachea were again demonstrated and the decision was made to irradiate the thymus with the

roentgen ray. The treatment consisted of three exposures of 140 r at weekly intervals, distance 25 cm., 115 kv., and 5 ma. A larger caliber although it had not yet attained to full size. Jackson^{5,6} and other experienced bronchoscopists have testified

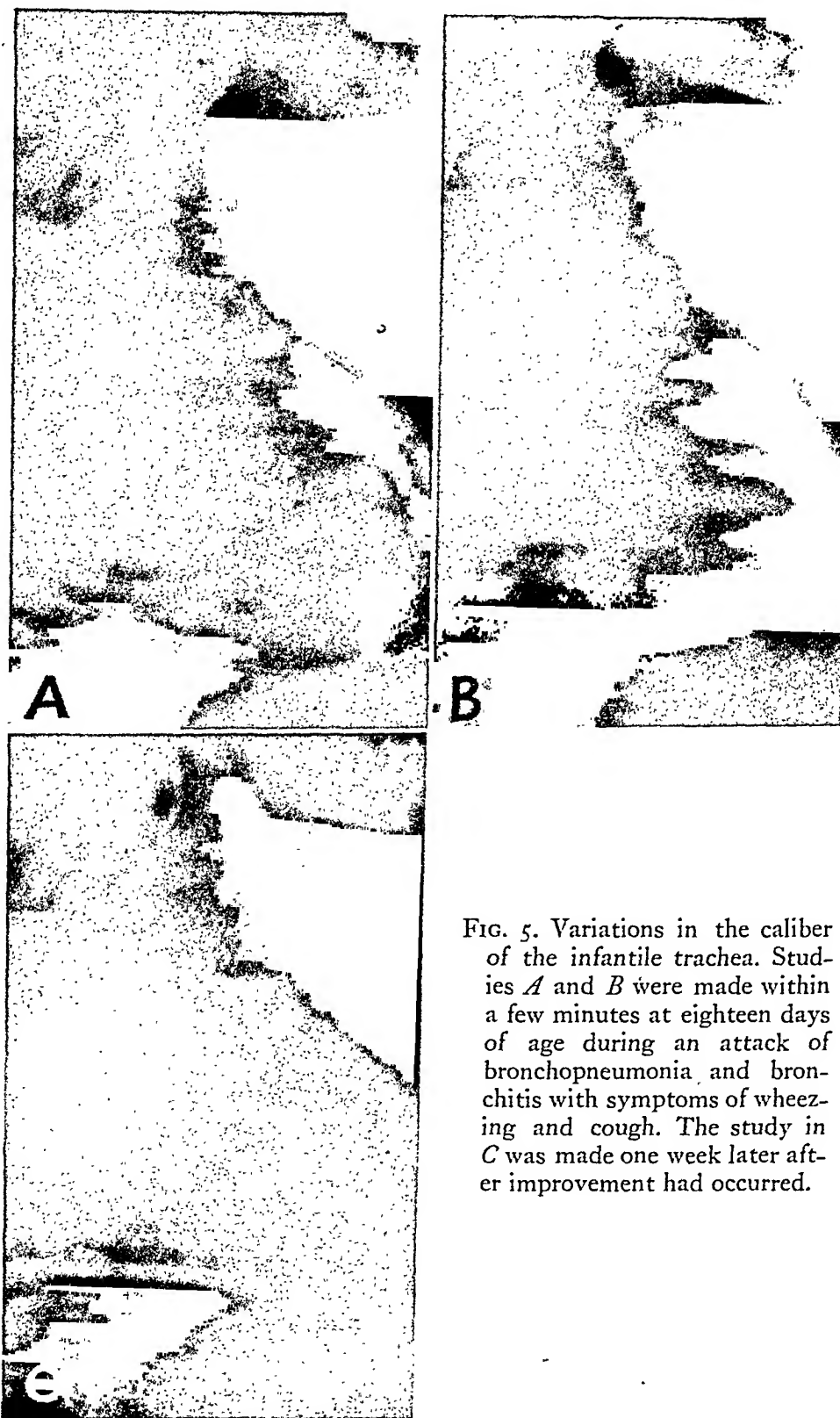


FIG. 5. Variations in the caliber of the infantile trachea. Studies *A* and *B* were made within a few minutes at eighteen days of age during an attack of bronchopneumonia and bronchitis with symptoms of wheezing and cough. The study in *C* was made one week later after improvement had occurred.

month later by the mother's account and our observations the breathing had become remarkably silent. The thymus had become inconspicuous and the trachea was of

to the fact that a large thymus may cause compression and stenosis of the trachea. It is admittedly difficult to provide autopsy proof for those who are skeptical of this



FIG. 6, *A*, *B*, and *C*. Variations in the caliber of the infantile trachea observed in a patient with esophageal atresia and tracheo-esophageal fistula which had been repaired. There was some postoperative stenosis at the site of anastomosis of the two esophageal segments. When the upper esophageal segment is distended the adjacent trachea tends to collapse.

interpretation of events but such a case has been reported by Lange⁷ in an article published in 1898 entitled "Sudden Death as the Result of Compression of the Trachea by an Enlarged Thymus." A baby died suddenly at three and a half months of age in cyanosis. The trachea was narrowed about 3 cm. above the bifurcation to one-

third of its normal caliber and the membranous portion of the trachea was abnormally broad in the area of narrowing. The thymus measured 7 by 4 by 3 cm., weighed 22.5 gm., and almost completely encircled the trachea in the area of narrowing. No other cause of death was found.

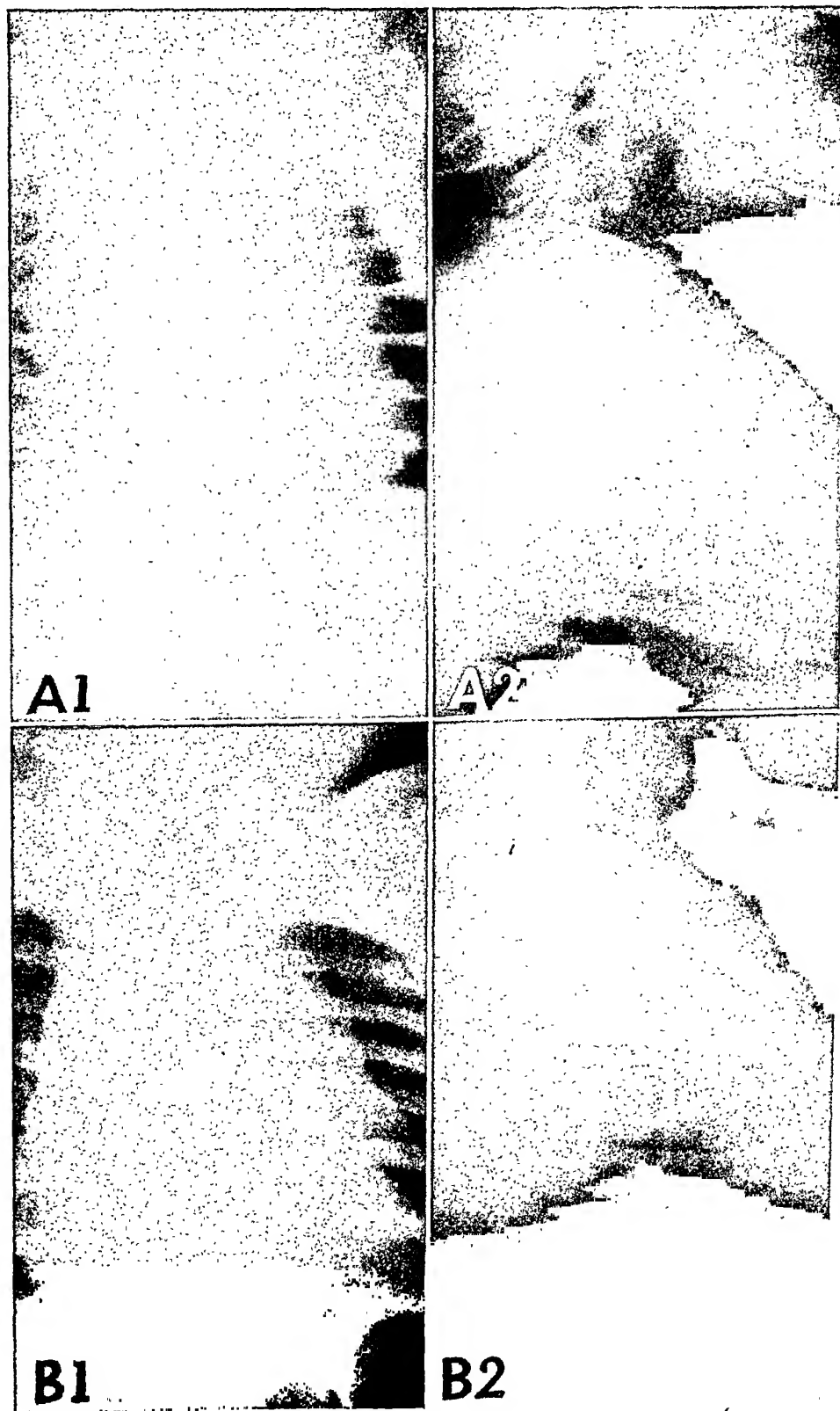


FIG. 7

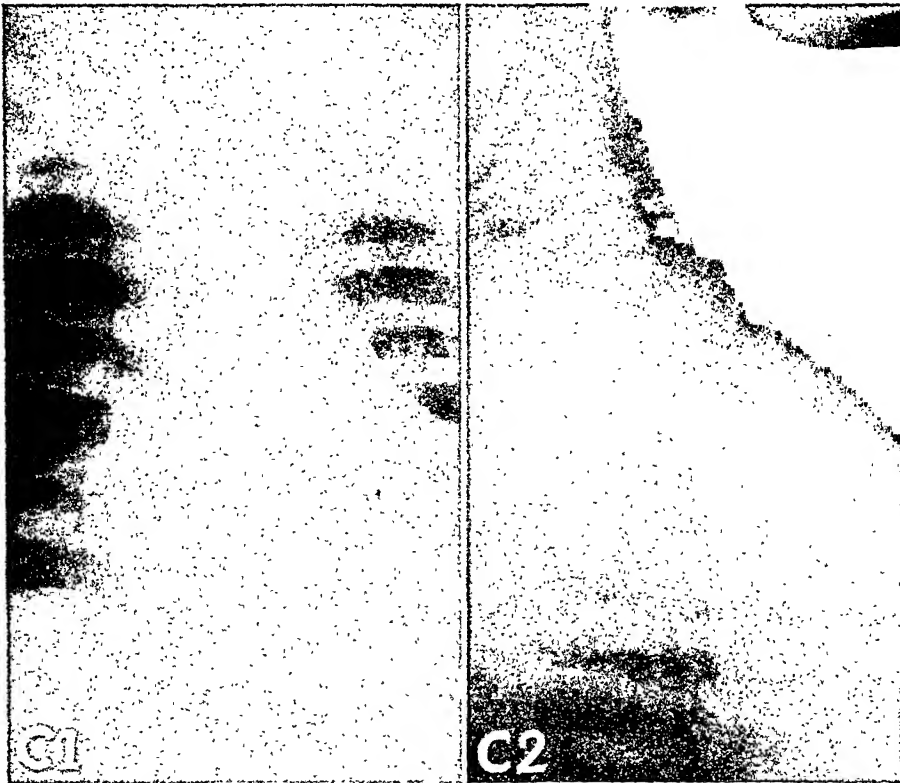


FIG. 7. *A*, large thymus and narrowing of the trachea demonstrated in a six week old infant with noisy breathing, cough and nasal discharge. *B*, similar findings demonstrated four months later. The noisy breathing had persisted in this interval with periods of aggravation during upper respiratory infections. *C*, appearance of the trachea and mediastinum one month after roentgen irradiation of the anterior chest. The noisy breathing had ceased. The thymus is now inconspicuous and the trachea is of large caliber.

CONCLUSIONS

Two cases of congenital tracheal stenosis associated with malformation of the tracheal cartilages have been reported.

The normal infantile trachea usually has a fairly fixed caliber but in some instances transient narrowing of the trachea may occur apparently due to soft tracheal cartilages.

Abnormal cervical and mediastinal masses, a large thymus, or a vascular ring impinging on the trachea will produce stenosis of the trachea depending in large part upon the development and pliability of the tracheal cartilages.*

110 Professional Bldg.
Detroit 1, Mich.

REFERENCES

- GABRIEL, E., and FEYRTER, F. Angeborene Trachealstenose bei einem $4\frac{1}{2}$ jährigen Kinde. *Jahrb. f. Kinderh.*, 1928, 121, 29-40.
- GRUENWALD, P. Case of atresia of the esophagu with tracheo-esophageal fistula in a 9-mm human embryo, and its embryological explanation. *Anat. Rec.*, 1940, 78, 293-302.
- GUISEZ, J. Malformation congénitale de la trachée. *Bull. d'oto-rhino-laryngol.*, 1927, 25, 289-292.
- HAARDT, W. Ueber angeborene Enge der Luft-röhre. *Wien. klin. Wchnschr.*, 1938, 51, 657-660.
- JACKSON, C. Thymic tracheo stenosis; tracheoscopy, thymectomy, cure. *J.A.M.A.*, 1907, 43, 1753-1756.
- JACKSON, C., and JACKSON, C. L. Diseases of the Nose, Throat and Ear. W. B. Saunders Co., Philadelphia, 1945.
- LANGE, J. Plotzlicher Tod in folge Compression der Trachea durch die vergrosserte Thymus. *Jahrb. f. Kinderh.*, 1898, 48, 119.
- MAREK, J. J. Congenital deformity of trachea. *Ohio State Med. J.*, 1940, 36, 1308.
- MONTANDON, A. Sténose congénitale de la trachée et malformations associées. *Pract. oto-rhino-laryng.*, 1944, 6, 179-191.
- SANKOTT, A. M. Ueber einen Fall mit angeborener Enge der Trachea und der Bronchien, Fehlen der Paries membranaceus tracheae,

* For discussion see page 184.

- Divertikelbildung usw. *Wien. klin. Wchnschr.*, 1922, 35, 391.
11. SCHEID, P. Missbildung des Trachealskelettes und der linken Arteria pulmonalis mit Erstickungstod bei $\frac{7}{12}$ Monate altem Kind. *Frankfurt. Ztschr. f. Path.*, 1938, 52, 114-214.
12. SGALITZER, M. Roentgenological examination of the power of resistance of the tracheal wall. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 56, 355-360.
13. WOLMAN, I. J. Congenital stenosis of the trachea. *Am. J. Dis. Child.*, 1941, 61, 1263-1271.



CONGENITAL OBSTRUCTIONS OF THE RESPIRATORY TRACT*

II. BRONCHIAL MALFORMATIONS

By WILLIAM A. EVANS, JR., M.D.

DETROIT, MICHIGAN

IT is reasonable to presume and there is evidence to indicate that atresia and stenosis with malformations of the cartilaginous rings occur in the bronchi as in the trachea. Tracheal malformations have been discussed in a previous communication.⁶

Atresia is much more commonly encountered in a bronchus than in the trachea. It is now a well recognized entity usually designated as an absence, agenesis or aplasia of the corresponding lung. Recent reviews indicate that about 50 well authenticated cases and perhaps over 100 have been reported in the literature.^{3,11,25} While the corresponding lung is usually absent it may be present as a hypoplastic remnant. The opposite lung is abnormally large and the mediastinum is displaced to the side of the atresia. This condition is quite compatible with an absence of symptoms and long life. There may be other congenital malformations, however, and malformations of the tracheal cartilages with or without tracheal stenosis have been frequently observed in the reported cases.^{3,5,13,14,21,24} The left lung is more often absent than the right in the ratio of about 2 to 1.

Bronchial stenosis as the result of maldevelopment of the bronchial wall has been reported by Overstreet.¹⁷ In his case emphysema was found in the left upper lobe of a three week old infant without symptoms. Dyspnea and cyanosis appeared at one month. The autopsy disclosed emphysema of the left upper lobe with a diffuse marked enlargement of the air sacs and with compression of the left lower lobe and of the right lung. There

was a slit-like orifice for the bronchus of the left upper lobe and the cartilage was absent in the posterior wall of the bronchus. Three cases were reported by Ferguson and Neuhauser.⁷ In 2 there was obstructive emphysema in the corresponding lung and in 1 there was a sudden death during an operation. In one of these cases an absence of the cartilaginous rings of the bronchus was demonstrated at autopsy and in another "a deficiency of the cartilaginous rings in the locality of the collapsible bronchi" was demonstrated microscopically.

CASE I. J. C. This infant had a cough and dyspnea since shortly after birth and evidence of a congenital cardiac malformation. There had been repeated admissions to another hospital and there the roentgen examination (Fig. 1A) was made at ten weeks of age. The patient was admitted to this hospital at five months of age exhibiting a loud systolic murmur and thrill, a silent left chest, and the roentgen findings shown in Figure 2B. Without knowledge of the previous findings the possibilities of agenesis of the left lung or of an atelectasis perhaps produced by the large heart or a vascular malformation were considered. Bronchoscopy showed the walls of the left main bronchus to be collapsed from what was supposed to be an external pressure effect. There was no foreign material in bronchial lumen and there appeared to be no air exchange through the left bronchus. At autopsy two days later a large heart was found with the enlargement involving chiefly the right auricle and right ventricle. The left auricle, which would be the chamber most closely approximating the left main bronchus, appeared normal except for a large interatrial septal defect. There was no malformation of the great vessels and nothing was found to produce a pressure effect on the left main bronchus.

* From the Children's Hospital of Michigan, Detroit, Michigan. Presented in part at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

Thus it seems proper to assume that there was a deficiency of the cartilage in the bronchial wall to account for the collapse of the bronchus and atelectasis of the left lung. Unfortunately, no particular attempt was made at autopsy to prove or disprove this contention.

CASE II. H. A. This infant exhibited a cough at three days of age followed by a wheeze. Both symptoms progressed but it was noted that the respiratory distress was relieved with the baby

bronchi (Fig. 2). The cysts seemed to arise from the bronchial walls where there were defects in the cartilaginous rings of both main bronchi. The cysts contained a clear viscid fluid.

Marshall and Cookson¹⁵ reported a tracheobronchial cyst which had presented externally to the tracheobronchial lumen in a female infant with symptoms of cough, cyanosis and dyspnea. The cyst was ad-

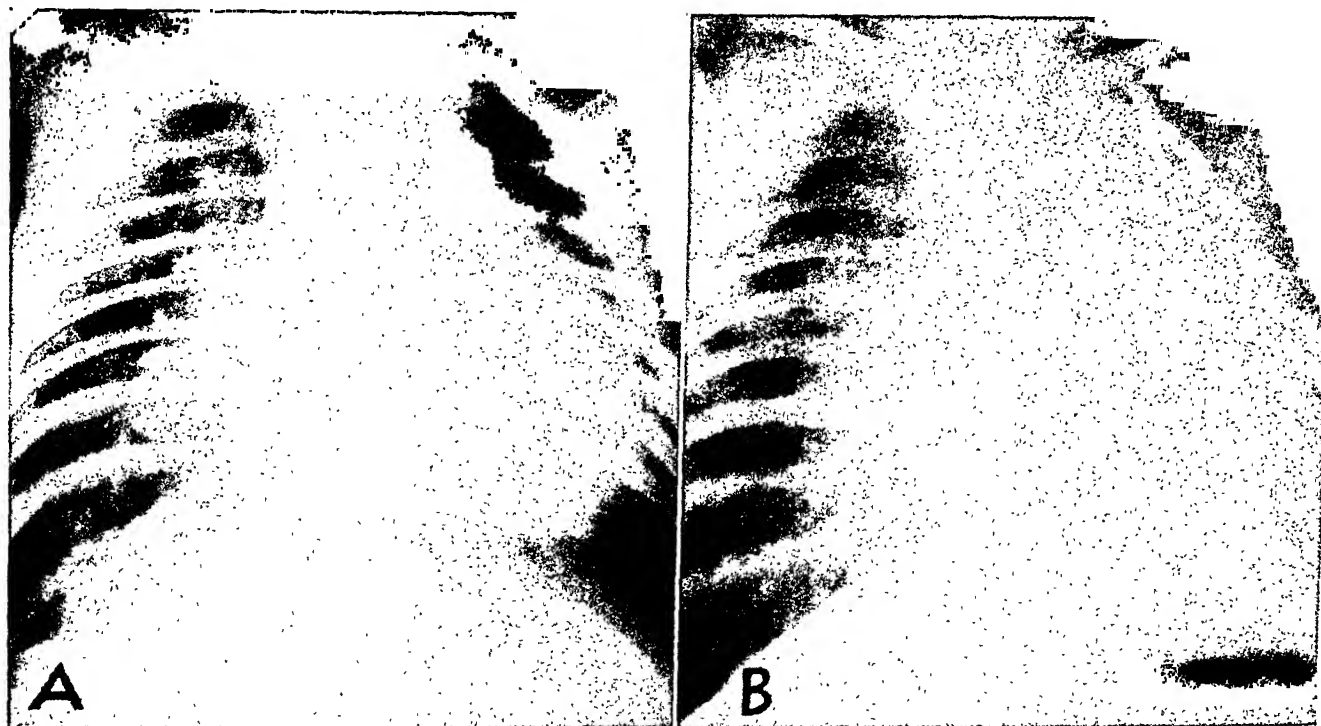


FIG. 1. Case I. *A*, roentgenogram at six weeks of age showing large heart and congestion in the lungs. *B*, roentgenogram at five months of age two days before death showing massive atelectasis of the left lung. This resulted from collapse of the bronchial wall (bronchoscopy) with no evidence of an intraluminal or extraluminal mass (autopsy) and therefore due presumably to a deficiency of the bronchial cartilage.

in an upright position. Respiration was noisy and high pitched. At ten weeks of age laryngoscopy revealed a small web anteriorly in the larynx and this disappeared after passing a bronchoscope.

The respirations were thought to be improved for a week after this procedure but then the wheezing recurred and gradually became worse. At seven months of age the infant was readmitted to the hospital after a spell of severe wheezing and cyanosis. The roentgen study of the chest, which was made only in the postero-anterior projection, showed only emphysema of the lungs and laryngoscopy was not informative. The child died suddenly the following day. At autopsy three cysts were demonstrated at the tracheal bifurcation obstructing both main

herent to the left bronchus and had resulted in atelectasis of the left lung. It had contained a jelly-like material and was lined by a ciliated epithelium. Wallace²³ has reported 2 cases with congenital webs in the bronchi. In one case the web was in the right main bronchus producing atelectasis of the right lung in a three month old female infant with irregular respirations. In the second case the web was in the left main bronchus with atelectasis of the left lung in a one day old female infant exhibiting shallow breathing and cyanosis. Wallace suggested that perforation of the webs and dilatation of the lumen might have been therapeutically effective.

The pathogenesis of congenital cystic disease of the lung is unsettled in its details but it seems profitable to consider at least some important forms of cystic disease as a malformation producing stenosis near the termination of one or more bronchial

much reduced. Bronchoscopy was not particularly helpful. As the child was observed during the next three weeks there was a progressive if somewhat intermittent aggravation of the respiratory distress, the right lung gradually increased in size and the left lung became ap-

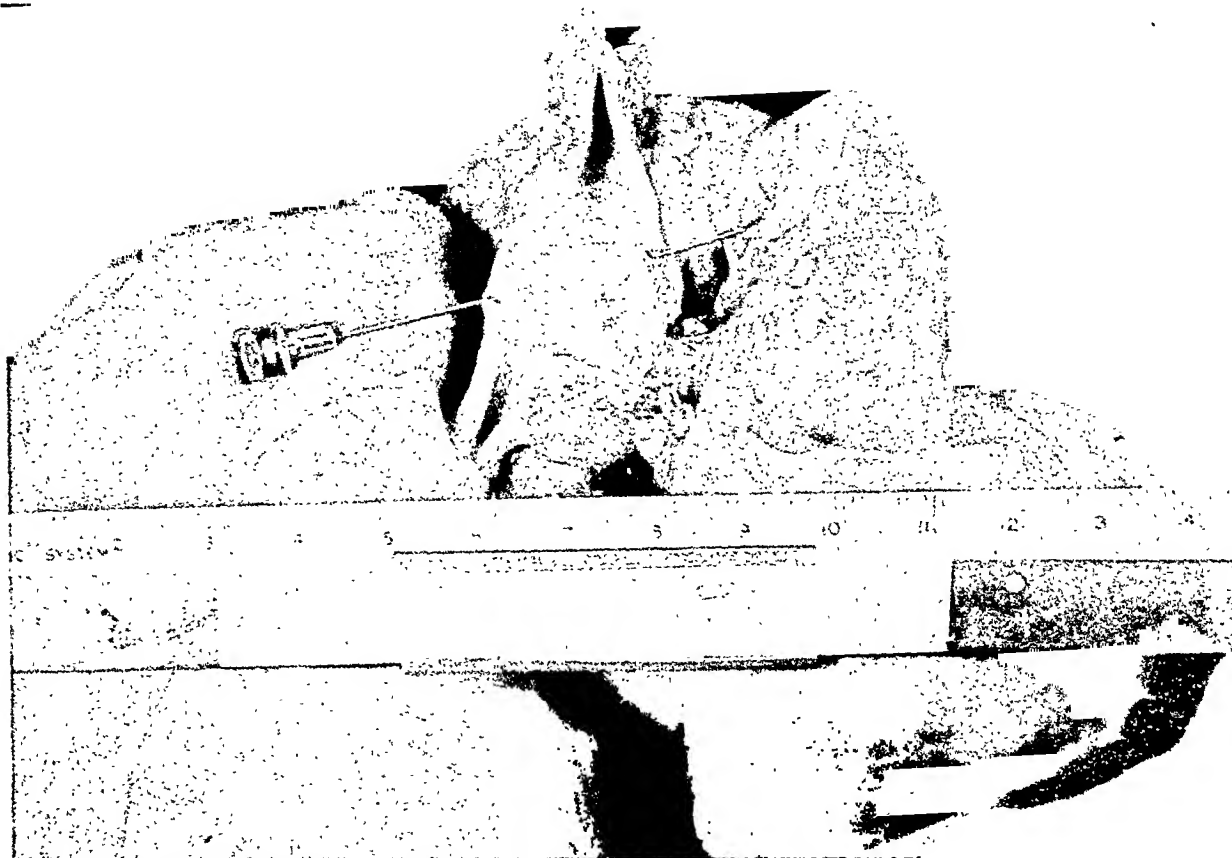


FIG. 2. Case II. Intraluminal bronchial cysts causing obstruction at the tracheal bifurcation. These were associated with defects in the cartilage of the bronchial wall demonstrated at autopsy.

radicles. Formerly the diagnosis of this condition was largely of academic interest but in recent years since it has been demonstrated that surgical intervention is feasible and often successful to the point of saving the life of an otherwise doomed infant the diagnosis has become a more important and gratifying one to make.

CASE III. A. C. This infant experienced a sudden onset of cyanosis and labored respiration at five days of age. On this day the right lung was found to be large and emphysematous with a cystic appearance in the lower half (Fig. 3A). It extended across the midline in the upper chest. The mediastinum was displaced to the left and the air content in the left lung was

parently completely atelectatic (Fig. 3B). Thoracentesis on the right did not aid in the diagnosis or provide relief of the patient's symptoms. It seemed that the right lung was not functioning in spite of its large size and that the only hope for the infant was to sacrifice the right lung and hope that the left lung would resume its function. Accordingly a right pneumonectomy was performed at the age of one month. The child did well following the operation and the left lung re-expanded to a considerable degree (Fig. 3C). On the 4th postoperative day the child was comfortable outside the oxygen tent with no cyanosis or dyspnea. Unfortunately the child died on the seventh postoperative day from a tension pneumothorax resulting from a loosened ligature on the right main

bronchus. The autopsy disclosed no other complication or cause of death. The sectioned right lung is illustrated in Figure 3D. It is evident that only the larger cysts in the lower lobe had been demonstrated in the roentgenograms.

not actually demonstrable in the roentgenograms, that when the cysts are numerous and relatively small the lung may appear simply emphysematous and furthermore that remaining normal pulmonary tissue which has been

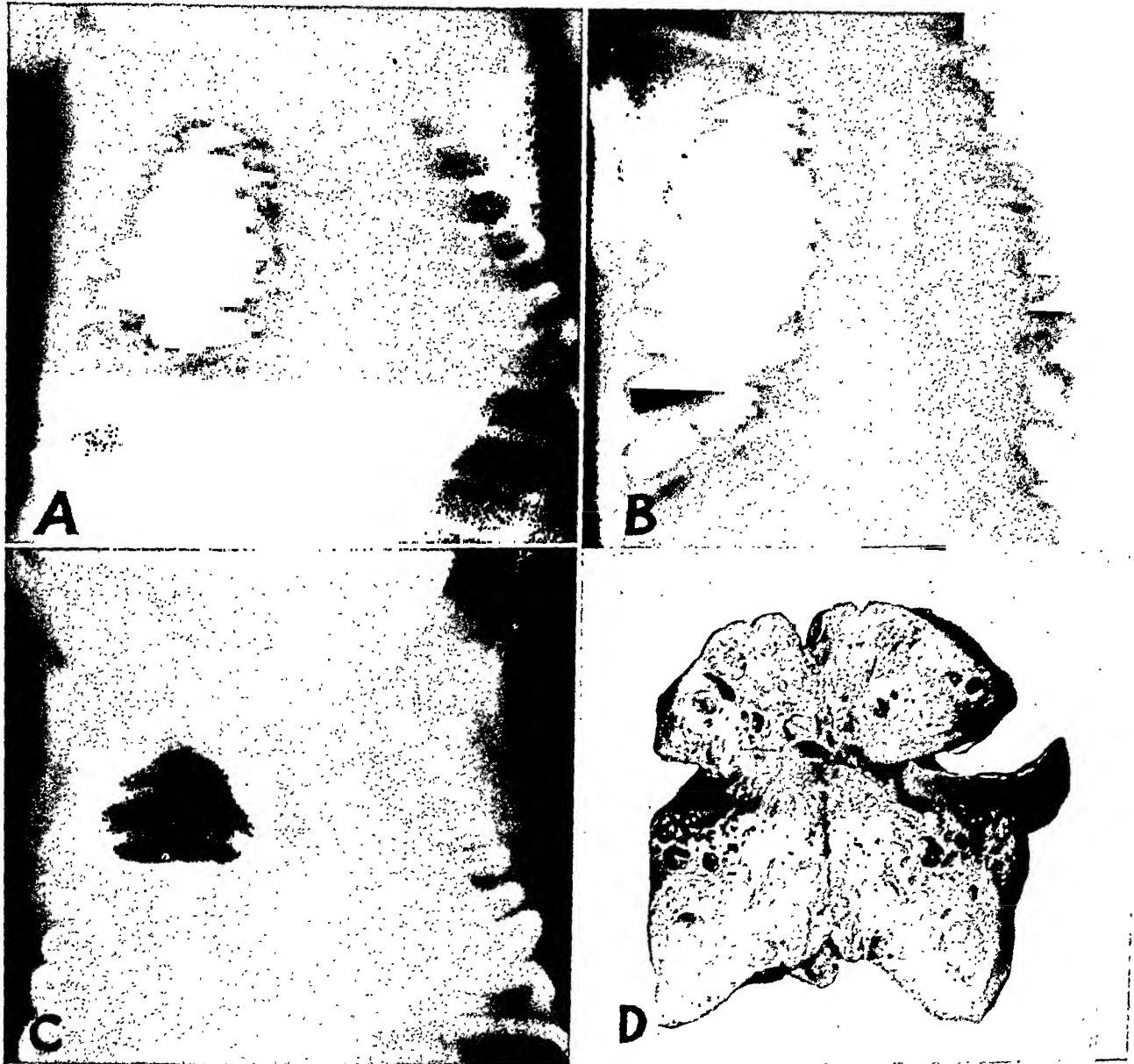


FIG. 3. Case III. *A*, roentgenogram at five days of age showing large right lung with a cystic appearance in the lower half and displacement of the mediastinum to the left. *B*, examination at thirteen days of age showing increasing size of the right lung, further displacement of the mediastinum to the left and atelectasis of the left lung. *C*, examination at one month of age, two days after a right pneumonectomy showing partial re-expansion of the left lung. *D*, sectioned right lung showing an extensive cystic malformation of the upper and lower lobes and atelectasis of the middle lobe which was otherwise normal.

The upper lobe appeared only as an emphysematous lobe and the collapsed but otherwise normal middle lobe was not evident at all. Microscopically numerous well formed alveoli were observed between the cysts in the cystic lobes. Thus it may be stated that cystic disease of the lung may be present when the cysts are

collapsed by the expanding cysts may not be demonstrable.

CASE IV. M. W. This infant had labored respirations soon after birth and was thought at another hospital to have an agenesis or atelectasis of the right lung. Certainly the right

lung appeared atelectatic in the roentgenogram (Fig. 4*A*) except for a small basal lateral segment, but we were also impressed by the large emphysematous appearing left lung and it was important to decide whether the symptoms and mediastinal displacement were due to a collapsed or malformed right lung or to a large expanding left lung. No cysts could be demonstrated in the left lung. The symptoms in this

age there was dyspnea, cough and cyanosis so that the patient was readmitted to the hospital but he was discharged improved after two weeks. Bronchoscopy was not helpful. Finally he was found to be losing weight, there was a persistent cough, and as his existence seemed precarious, a left pneumonectomy was decided upon and was performed at three and a half months of age. He died four hours later. The

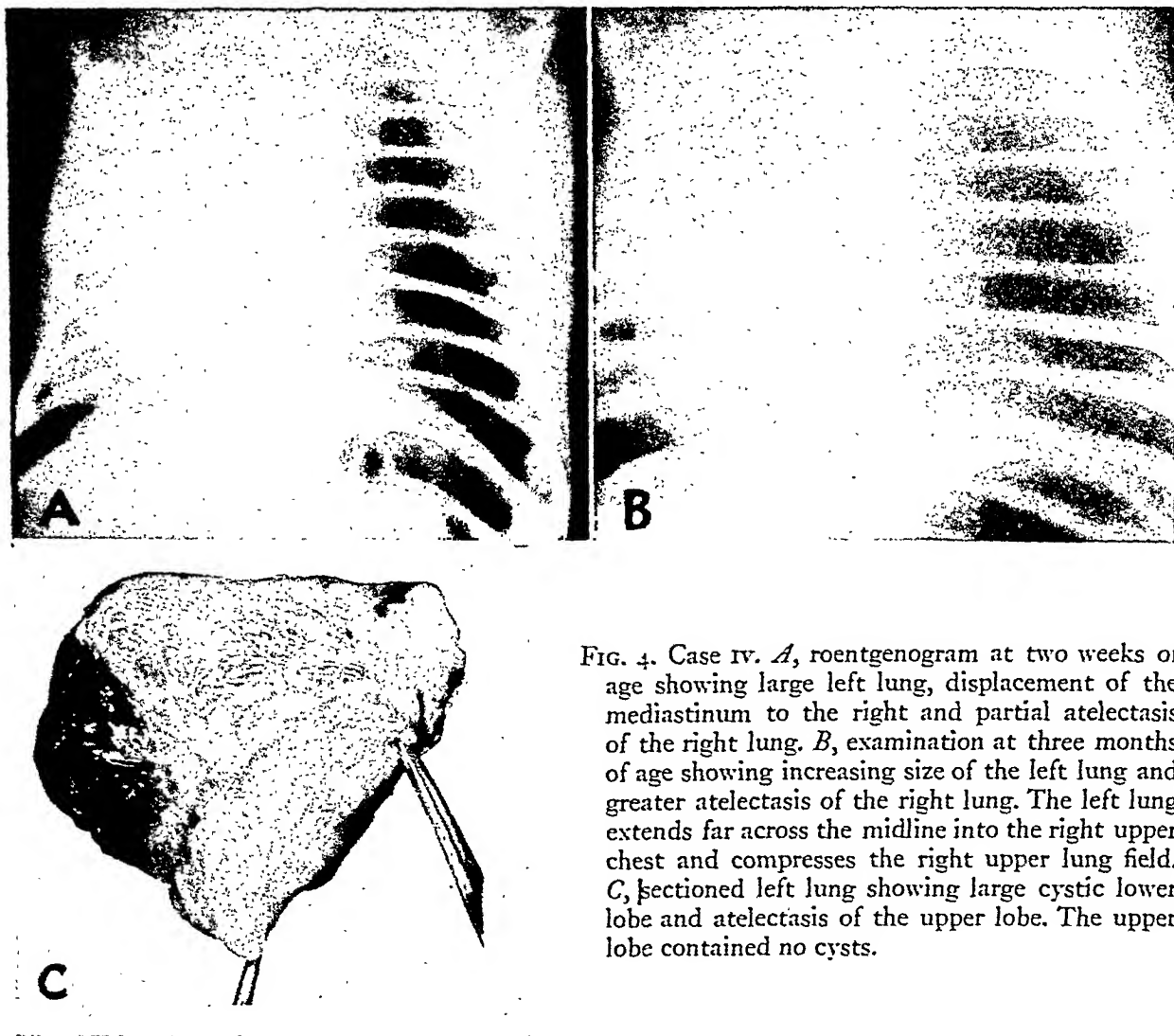


FIG. 4. Case IV. *A*, roentgenogram at two weeks of age showing large left lung, displacement of the mediastinum to the right and partial atelectasis of the right lung. *B*, examination at three months of age showing increasing size of the left lung and greater atelectasis of the right lung. The left lung extends far across the midline into the right upper chest and compresses the right upper lung field. *C*, sectioned left lung showing large cystic lower lobe and atelectasis of the upper lobe. The upper lobe contained no cysts.

case were less severe than those in Case III and at times the baby seemed to be doing well. However, as the patient was observed during the next three and a half months the left lung slowly increased in size and the upper portion of the left lung extended more across the midline into the right upper chest (Fig. 4*B*). Perhaps the anomalous curvilinear shadow at the left base suggests a cystic malformation. With a mild respiratory infection at two months of

left lower lobe (Fig. 4*C*) was very large and riddled by multiple cysts from 0.1 to 1.5 cm. in diameter. The left upper lobe was normal except that it had been collapsed to a thin cap over the left lower lobe. It was the impression here that surgical intervention had been too long delayed and that if it had been accomplished sooner the collapsed but otherwise normal portions of the lung would have been more readily able to expand and resume their function.

CASE V. B. N. This infant, a private patient of Dr. John Pollack, was born in July, 1947, and lived through the following winter suffering only mild upper respiratory infections which were in no way alarming. At a routine office visit in April, 1948, Dr. Pollack observed a shift of the mediastinum to the right under the fluoroscope and referred the patient for further study. A large cyst-like cavity in the left upper

infection and atelectasis, and on July 21, 1948 Dr. Robert E. Gross of Boston excised the cyst in the left upper lobe and closed the defect in the upper lobe by approximating the raw surfaces. To date there has been a satisfactory recovery. This, then, is an example of a single expansile air cyst in the lung which had produced much less severe symptoms, if indeed any symptoms at all, than in Cases III and IV and

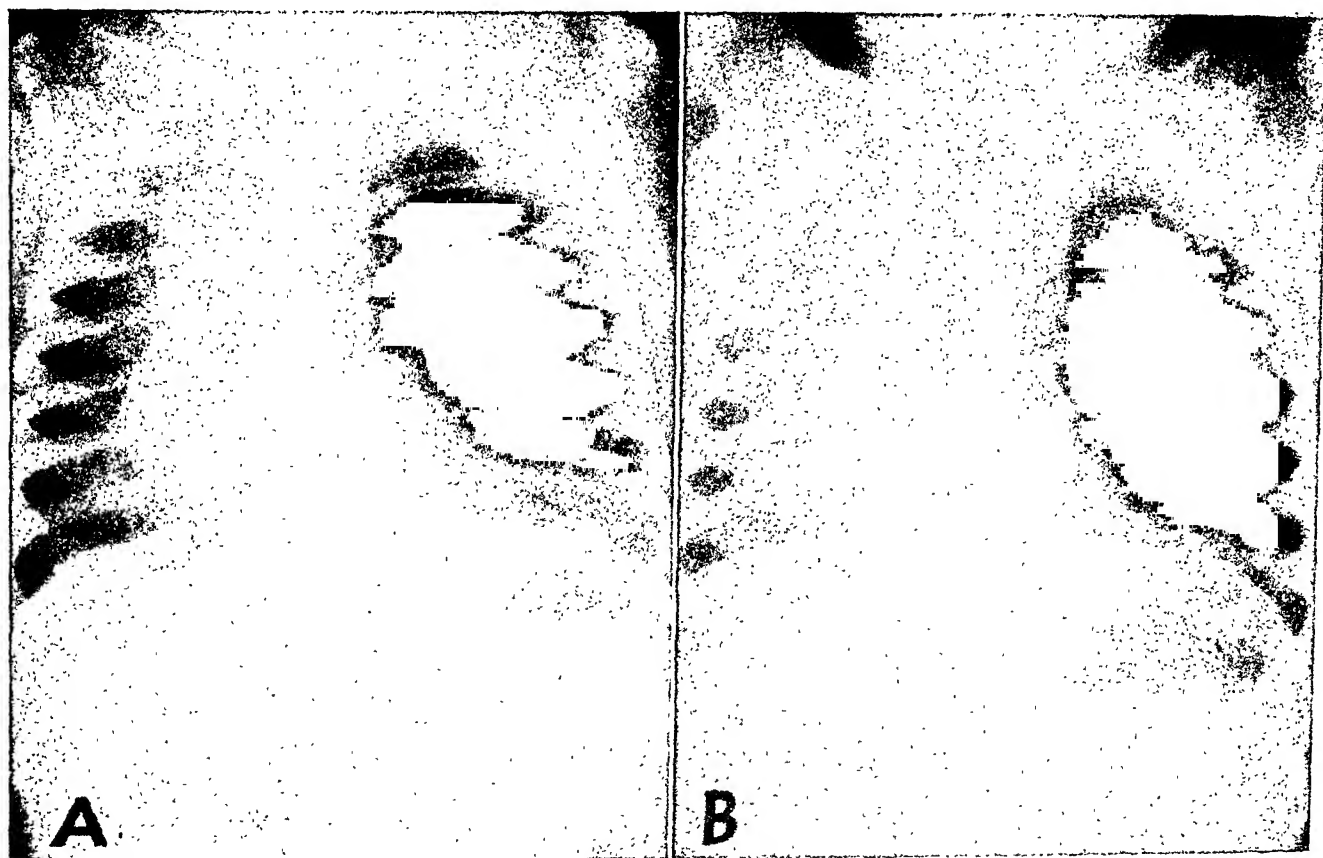


FIG. 5. Case v. *A*, roentgenogram at nine months of age showing large cystic lesion in the upper lobe of the left lung compressing the left basal lung field and displacing the mediastinum to the right. *B*, re-examination at one year of age showing increasing size of the cystic lesion, more displacement of the mediastinum and diminishing aeration of the right lung. A large cyst was successfully removed from the left upper lobe with an uneventful recovery.

lobe was demonstrated on the roentgenograms (Fig. 5*A*). It extended across the midline superiorly and displaced the mediastinum to the right. The lower lung field was compressed but there was no evident reaction in the adjacent lung or pleura. Bronchoscopic studies showed nothing remarkable in the tracheobronchial tree. At a subsequent roentgen examination two and a half months later (Fig. 5*B*) the cyst had increased in size, the lungs elsewhere were less well aerated and there was perhaps slightly more displacement of the mediastinum to the right. Operation was deemed advisable to forestall complications of

one where the diagnosis and the surgical treatment were less difficult.

In 1926 Miller¹⁶ writing on "Congenital Cystic Lung" stated that "radical cure is out of the question." In 1936 Gale, Keeley and Coon¹⁰ reported a successful pneumonectomy for cystic disease in an adult. In 1943 Fischer, Tropea and Bailey⁸ reported a successful lobectomy of the right upper and middle lobes for cystic disease in an infant one month old. In 1946 Gross¹² performed a successful left pneu-

monectomy for cystic disease of the left upper lobe in a three week old infant. Similar cases have since been reported by Burnett and Caswell⁴ in Philadelphia and by Brechling² in Sweden in 1948.

Surgical removal of the cyst, cystic lobe, or cystic lung now seems the most feasible therapeutic approach for expanding lesions that threaten the function of the remaining lung and also for progressive emphysema without cysts due to bronchial stenosis in such cases as have been reported by Overstreet¹⁷ and Ferguson and Neuhauser.⁷ Aspirations may give temporary relief from a single cyst,^{1,8,9,16,22} but they are not effective if there are multiple cysts as in Case III. The injection of sclerosing material into the cyst by thoracentesis has not been successful²⁰ and the attempt to obliterate the bronchial communication of the cyst by the bronchoscopic injection of sclerosing material seems hazardous at best. Cysts may disappear spontaneously,¹⁹ may be dormant without symptoms,¹⁹ or may become infected.^{2,18}

In the differential diagnosis of expansile air cysts the following conditions are to be considered: diaphragmatic hernia, pneumothorax, agenesis and atelectasis in the opposite lung, and emphysema due to partial obstruction in one of the larger bronchial radicles. Consideration must also be given to the cavities which are commonly seen in infants and children during the course of pneumonia and which have been variously called acquired cysts, pneumocysts, aseptic lung abscess, lung abscess, localized bullous emphysema, and regional obstructive emphysema. An appearance suggesting congenital cystic disease is sometimes seen in a slowly resolving atelectasis or inflammatory consolidation and in bronchiectasis, except that in these instances the lung tends to be contracted rather than expanded.

CONCLUSIONS

Two cases of bronchial obstruction due to congenital malformations have been

reported. In one there was collapse of the bronchial lumen with atelectasis of the lung presumably due to a deficiency of the cartilage in the wall. In another there was partial obstruction due to cysts in the bronchial lumen with defects in the cartilaginous structures of the bronchial wall. Comparison has been made with similar cases reported in the literature.

Three cases of congenital expansile air cysts in the lungs treated surgically have been reported.

Surgical removal of an expanding segment of lung whether due to obstructive emphysema or cystic disease is feasible and desirable when the expanding segment threatens the function of the remaining lung.

110 Professional Bldg.
Detroit 1, Mich.

REFERENCES

1. ANSPACH, W. E., and WOLMAN, I. J. Large pulmonary air cysts of infancy. *Surg., Gynec. & Obst.*, 1933, 56, 635-645.
2. BRECHLING, S. Case of congenital cystic lungs in a child. *Acta paediat.*, 1948, 35, 172.
3. BURGER, R. A. Agenesis of the lung, with review of literature. *Am. J. Dis. Child.*, 1947, 73, 481-488.
4. BURNETT, W. E., and CASWELL, H. T. Lobectomy for pulmonary cysts in a fifteen day old infant with recovery. *Surgery*, 1948, 23, 84.
5. ELWARD, J. F. Roentgen aspects of congenital aplasia of lung. *Radiology*, 1936, 27, 667-671.
6. EVANS, W. A., JR. Congenital obstructions of the respiratory tract. I. Tracheal malformations. *AM. J. ROENTGENOL. & RAD. THERAPY*, August, 1949, 62, 167-176.
7. FERGUSON, C. F., and NEUHAUSER, E. B. D. Congenital absence of the lung (agenesis) and other anomalies of the tracheobronchial tree. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 459-471.
8. FISCHER, C. C., TROPEA, F., JR., and BAILEY, C. P. Congenital pulmonary cysts. *J. Pediat.*, 1943, 23, 219-223.
9. FLEMING, G. B. Five cases of congenital lung cyst. *Arch. Dis. Childhood*, 1934, 9, 201-212.
10. GALE, J. W., KEELEY, J. L., and COON, H. M. Total pneumonectomy for congenital cystic disease of the lung. *J. Thoracic Surg.*, 1937, 6, 626-633.
11. GARBER, R. L. Congenital aplasia of the lung.

- AM. J. ROENTGENOL. & RAD. THERAPY, 1945, 53, 129-131.
12. GROSS, R. E. Congenital cystic lung. *Ann. Surg.*, 1946, 123, 229-237.
 13. HURWITZ, S., and STEPHENS, H. B. Agencsis of the lung. *Am. J. M. Sc.*, 1937, 193, 81-87.
 14. KILLINGSWORTH, W. P., and HIBBS, W. G. Agencsis of the lung. *Am. J. Dis. Child.*, 1939, 58, 571-580.
 15. MARSHALL, P. C., and COOKSON, H. A. Tracheo-bronchial cyst. *Lancet*, 1943, 1, 305-306.
 16. MILLER, R. T., JR. Congenital cystic lung. *Arch. Surg.*, 1926, 12, 392-405.
 17. OVERSTREET, R. M. Emphysema of a portion of the lung in early months of life. *Am. J. Dis. Child.*, 1939, 57, 861-870.
 18. SAVAIN, W., and BRYANT, J. E. Congenital cystic disease of the lung. *Radiology*, 1946, 47, 156-162.
 19. SCHENCK, S. G. Congenital cystic disease of the lungs. AM. J. ROENTGENOL. & RAD. THERAPY, 1936, 35, 604-629.
 20. SWANSON, W. W., PLATOU, E. S., and SADLER, W. Congenital cyst of the lung. *Am. J. Dis. Child.*, 1928, 35, 1024-1031.
 21. VAN LOON, E. L., and DIAMOND, S. Congenital absence of the right lung. *Am. J. Dis. Child.*, 1941, 62, 584-589.
 22. VOLLMER, H. Cystische Lungengebilde im Kindesalter. *Ztschr. f. Kinderh.*, 1928, 46, 810-817.
 23. WALLACE, J. E. Two cases of congenital web of a bronchus. *Arch. Path.*, 1945, 39, 47-48.
 24. WASMUHT, K. Ueber zwei Fälle von Hyperplasie der linken und totaler Agencsie der rechten Lunge. *Frankfurt. Ztschr. f. Path.*, 1938, 52, 519-528.
 25. WIDERMANN, A., and PETERS, C. H. Agencsis of the lung. *J. Pediat.*, 1946, 28, 204-206.

DISCUSSION

DR. VINCENT W. ARCHER, Charlottesville, Virginia. Dr. Evans has covered the malformations very nicely. There is nothing to be added to this. However, there are two or three things that come up as far as differential diagnoses are concerned which need somewhat more attention.

Dr. Evans did not mention one of the conditions that we always look for since the days of that perfectly beautiful exhibit in Detroit in 1932 by Dr. Pancoast and Dr. Pendergrass on the lateral views of the neck which won a gold medal at the American Medical Association. We have been very much interested in retro-

pharyngeal abscesses. They are not at all uncommon in childhood, and particularly in early childhood as a complication of other infections.

In one of the slides that Dr. Evans showed, it looked to me very much as though there might have been a complicating retropharyngeal abscess. We have found several of these and in the days before chemotherapy they were drained. That was one phase that I think should be considered. Another is what all pediatricians call bronchiolitis in which there is an occlusion of a great part of the smaller divisions of the bronchial tree by mucus, along with infection.

Roentgenologically, you see very little. There is some haziness, generalized haziness of the lung fields, but fluoroscopically you will see quite a marked limitation of the motion of the diaphragms.

Still another infection which, I think, must be considered is diphtheria. We see quite a bit of diphtheria and on the basis of an adult that we saw years ago, we think that we have a fairly definite picture in infections which involve the trachea immediately below the larynx.

In this patient, it was a question of malignancy and she was biopsied and it was inflammatory, and on the roentgenogram we saw this dumb-bell shaped constriction of the trachea. We treated her with radiation similar to that described by Dr. Osmond for thyroiditis and we had a very prompt recovery. During the last year, there was an epidemic in one locality. Several of the children brought over to us came with the thought that they had diphtheria. Cultures were negative and yet all of them showed the same dumb-bell narrowing of the trachea but immediately beneath the larynx. Those children, we believe, had an infection in the wall of that trachea analogous to the one that I described which was proved bacteriologically.

There is one thing which might be mentioned. All of us see these children when they come in, with noisy respiration, etc. I think it is important to look at them during the phases of respiration and if you see a child who is struggling for breath, and has a dip-in of the xiphoid on respiration, then it is necessary to carry out all of these things in order not to miss the diagnosis since there may be a foreign body or some stricture either involving a large portion of the bronchial tree or above the bifurcation of the trachea.

LESIONS OF THE DIAPHRAGM*

By E. L. JENKINSON, M.D.

Director, Department of Radiology, St. Luke's Hospital

CHICAGO, ILLINOIS

THE diaphragm is a musculo-fibrous dome-shaped structure which is attached to the lower margin of the thorax and to the upper lumbar vertebrae, arising embryologically in the region of the neck, and maintains cervical relations through its innervation by the phrenic nerves, which spring one on each side, usually from the third to the fifth cervical nerves. The central portion of the diaphragm is an aponeurosis or central tendon into which is inserted the musculature which arises from the xiphoid cartilage, the cartilages and tips of the last six or seven ribs and by means of the crura from the sides of the first four lumbar vertebrae on each side. The diaphragm presents three main openings. Anteriorly and to the right is the opening for the inferior vena cava, posterior to the opening and in the midline is the esophageal opening. The aortic opening is posterior to the esophageal opening and is actually behind the diaphragm. Anteriorly to each side of the sternum the foramen of Morgagni is located. The central portion of the diaphragm is frequently absent; occasionally the diaphragm is incompletely developed dorsally on the left side. Defects of the right diaphragm are not common.

During the last decade, diaphragmatic hernia has become one of the common gastrointestinal conditions encountered in hospital practice. Prior to the extensive use of the roentgen ray, hernias and other lesions of the diaphragm were not commonly suspected and were identified only at autopsy. As the importance and accuracy of roentgen diagnosis was appreciated, the internist became aware of the symptoms often accompanying diaphragmatic hernia, and at the present time many cases are accurately diagnosed when sent to the roentgenologist.

The symptoms caused by hernia are varied and bizarre, and the size of the hernia has much to do with the severity of the symptoms. The early diagnosis of a small hernia is very important because of the possibility of the hernia becoming larger if proper treatment is not instituted. If a patient with a small hernia is allowed to take large quantities of food and fluids and then lies down, the intragastric pressure increases and the hernia becomes larger. I am sure you are all familiar with the cardiac symptoms caused by or at least accompanying diaphragmatic hernia. According to our cardiologists, symptoms develop which are often difficult to differentiate from angina or the pain from coronary thrombosis. The symptoms are often transient probably due to the fact that the hernia is of the recurrent or intermittent type; in other words, the hernia may be present at one time and absent at others, the "sliding type." The reason that the hernia can be found by one roentgenologist and not by another, even though both examinations were very thorough, is that the stomach may not herniate at all times. In some patients, however, the hernia may be fixed due to adhesions.

Diaphragmatic hernias are usually found after the fourth decade of life about equally divided between males and females. Rigler has found a high incidence (18 per cent) in 195 women during pregnancy. Diaphragmatic hernias are very infrequent before forty years of age. Those seen in children are usually due to large developmental defects through the dome of the diaphragm and are not common through the esophageal opening. Diaphragmatic lesions we have seen in children have been due to absence of all or part of the diaphragm. Most of the patients were seen

* Carman Lecture, presented before the St. Louis Medical Society, St. Louis, Mo., November 4, 1947.

when they were very young and the lesions were undoubtedly of the congenital type. LeWald has reported a marathon runner with an absence of the diaphragm on one side.

Diaphragmatic hernias are either congenital, acquired or traumatic. We believe that those which develop later in life are acquired, whereas the congenital type occurs in infants and the symptoms are very pronounced and death often occurs, especially if the opening is very large and most of the abdominal viscera are in the chest. If the diagnosis is made promptly, our present day thoracic surgeons can operate and repair the rent in the diaphragm in the very young infant.

The traumatic hernia is due to an injury and does not commonly involve the esophageal opening. The diagnosis is not difficult, and this type of case is met with more in traumatic surgery than in general medicine. The hernia, or better, evisceration, does not as a rule involve any of the normal openings of the diaphragm; usually the dome is torn. Herniation of the viscus usually occurs through one of the foramina of the diaphragm. The esophageal and Morgagni are the usual sites, although the esophageal is by far the commonest location.

Congenital hernia usually occurs through the left diaphragm as the liver protects the right diaphragm, and even though a defect may be present, the liver blocks the entrance of a viscus into the thorax. We have seen only 2 cases of right-sided hernia, one was in a stillborn with an absence of the right diaphragm and the other in a woman who had assumed a knee-chest position for many months allowing the transverse colon to herniate through an opening in the right diaphragm.

Hernias through the esophageal opening of the diaphragm are now thought to be of the acquired type. They have a sac composed of one or more of the layers of the diaphragm. Hernias occurring through the foramen of Morgagni, "para-sternal," are also classed as acquired and usually have a sac. Congenital hernias due to large

developmental defects are devoid of a sac and have the serous coat of the viscus as a cover. The traumatic hernia or evisceration likewise has no sac.

Many factors have been attributed as the cause of acquired diaphragmatic hernia. I will mention some of the more common as taken from the literature. Increased intra-abdominal pressure is given as a common cause by many writers. Decreased intrathoracic pressure has also been given as a cause. The diaphragmatic esophageal membrane at the esophageal opening is quite strong in early life and this may account for the infrequency of diaphragmatic hernia during childhood. Later in life the membrane becomes thinned and with increased intra-abdominal pressure the stomach is forced upward into the chest. With relaxation of the tissues about the hiatal orifice, one can see why an esophageal hiatal hernia may occur with increased intra-abdominal pressure due to obesity, especially in a patient with a muscular abdominal wall.

Gilbert and his associates found it difficult in the "experimental animal" to produce a hernia with the chest closed and the abdomen open. They doubt the importance of decreased intrathoracic pressure as a cause *per se*. Deep inspiration in constant cough might be a factor as well as the increased intra-abdominal pressure. Difference in pressure between the thorax and abdomen may be a contributing factor. Von Bergmann some years ago suggested that many hernias might be due to traction on the esophagus from above in response to vago-vagus reflex initiated by some stimulus originating in the upper abdominal viscera.

The longitudinal fibers of the lower esophagus are continuous with the longitudinal fibers of the stomach and are motivated by the vagus nerve shortening of these fibers which would tend to pull the stomach upward and through the relaxed hiatal orifice.

Kuckuck quoted by von Bergmann stimulated the vagus trunk in the neck of the rabbit and was able to demonstrate a shortening of the esophagus, and in some

cases the cardiac end of the stomach extended above the diaphragm. The esophagus is very susceptible to nervous stimuli as witness globus hystericus, cardiospasm and esophageal symptoms occurring reflexly in early stages of carcinoma of the stomach.

Gilbert and his co-workers confirmed the work of Kuckuck in dogs. The vagus trunk in the neck was electrically stimulated, the esophagus was shortened and the stomach was pulled up to but not through the hiatal opening. The chest was closed in the experimentation. Later when the chest was opened, the stomach was pulled up through the hiatal orifice. Later in some further work, Gilbert and his co-workers produced shortening and lengthening of the esophagus recorded on a drum by a lever fastened to the esophagus.

Irritation of the peritoneum by scratching, manipulation of the lobes of the liver, distention of the gallbladder and stretching of the stomach wall all caused a shortening of the esophagus and a pulling up of the stomach to and in some cases through the hiatal orifice. Other writers have attributed many conditions as the cause of hiatal hernia such as fatigue, nervous factors and vagotonia. Personally, we believe the diaphragmatic membrane which relaxes with age accompanied by obesity are two very important causes.

In Gilbert's series of 48 cases, all carefully studied, 27 in which there was some possible source of vago-vagal reflex, in 2 of the cases the hernia was incarcerated, in 3 patients there was evidence of blood in the stools. Thirty of the patients came under observation because of gastrointestinal symptoms, 16 came under observation because of the symptoms of angina pectoris and 2 because of paroxysmal auricular fibrillation which came on when the hernia was present. Stooping over is frequently a cause of the symptoms, especially in the obese. Reduction in weight often caused relief of symptoms.

ROENTGEN DIAGNOSIS

Careful roentgenologic observation is imperative if hiatal hernias are to be

identified. Hernias are often recurrent, and it may be necessary to examine a patient many times before the hernia is found. Even the fixed type of hernia can change.

The identification of the stomach folds is the deciding factor in the differentiation of the hernial sac from a large phrenic ampulla; this is not always easy, especially in large patients.

The roentgenoscopic examination of the diaphragm reveals normal excursions in the presence of hiatal hernia. In the congenital type with a large rent, the excursions are often impaired. Hernias through the central tendon of the diaphragm often cause changes in the excursions.

Frequently the possibility of a hernia is suspected during the initial roentgenoscopic examination before the barium meal is given. Gas can be seen above the diaphragm adjacent to the cardiac opening. This is not a constant finding if the hernia is of the recurrent type.

The esophagus, in our experience, is usually long and redundant in hiatal hernias. If the hernia is of the peri-esophageal type, the stomach passes upward around the esophagus, displacing the esophagus to the right and backward, entering the stomach below the diaphragm. If the hernia is of the direct type, the esophagus is carried upward and is usually redundant in the chest and enters the stomach above the diaphragm. This type is often confused with a congenital short esophagus. In congenital short esophagus, the herniated portion of the stomach is always above the diaphragm; in other words, it is developed in the chest and has failed in its downward transit. It can be classed as a partial thoracic stomach.

The differentiation of hernia and congenital short esophagus is important from the surgical standpoint. If the esophagus is of the congenital short type, it will be very difficult, if not impossible, to bring the stomach down into the abdominal cavity. The surgeon should have the information before considering surgery—a phrenic exeresis will be more helpful in the congenital short esophagus.

The phrenic ampulla has been incorrectly diagnosed congenital short esophagus, and at times it may be difficult to differentiate the two conditions due to the band-like constriction at its upper margin, not unlike esophageal sphincter. The phrenic ampulla is a functional or physiological bulbous-like dilatation of the lowermost portion of the esophagus. It is demonstrated where the esophagus is completely or moderately well filled. It is apparently not responsible for clinical symptoms and is of importance only in that it must be recognized as such and not confused with a hernia or a congenital short esophagus which it may closely simulate. The rugae of the esophagus are quite characteristic and are quite readily demonstrated with almost any type of barium meal. They appear as continuous, long, thin lines of barium and are not often branched or broken in appearance. Phrenic ampulla is common after forty years of age in a hypersthenic person. It is exaggerated by rapid swallowing of the barium or by increased intra-abdominal pressure, such as performing the Valsalva experiment. The ampulla partially or completely empties at the end of the act of swallowing. The most important roentgenological finding in the differentiation of phrenic ampulla and congenital short esophagus and hernia is the rugal pattern seen either roentgenoscopically or roentgenographically. If the rugae are parallel with the long axis and not broken, one can feel sure he is dealing with a phrenic ampulla and not a part of the stomach.

Thoracic stomach is a developmental defect in which the entire stomach is permanently in the thorax. The esophagus is very short and the pyloric portion of the stomach passes through the esophageal opening of the diaphragm. The condition is compatible with life. One of the patients we have in our series was sixty-seven years of age at the time of examination. All he complained of was fullness in the chest and a desire to expectorate due to the fact that the fluid came up into his mouth.

To identify these diaphragmatic lesions

it is necessary to be very meticulous, in other words, be hernia conscious. While some cases can be readily diagnosed in the upright position, a large percentage will be missed if patients are only examined in the upright position. Every patient in whom a hernia is suspected must be roentgenoscoped and roentgenographed in the recumbent position, including both anteroposterior and posteroanterior views in the Trendelenburg position. During roentgenoscopy, the patient should be asked to strain, bear down as when going to stool. Also, the Valsalva experiment is very useful. The right lateral and the George position is also of great value during roentgenoscopy. The length of the esophagus and its relation to the hernia can be determined in these positions.

SUMMARY

Diaphragmatic hernias are not uncommon and may be accompanied by very bizarre symptoms often simulating angina pectoris and coronary disease. The identification of hernias is fundamentally a roentgenological problem, and frequent careful examinations are often necessary before the hernia can be diagnosed. Hernias are very often of the recurrent type. Congenital hernias are usually devoid of a sac, whereas the acquired type usually has a sac.

Seventy-eight per cent of non-traumatic hernias occur on the left side. Twenty-five per cent are through the esophageal hiatus, 25 per cent occur posteriorly and about one-sixth are central. Twenty-two per cent of hernias occur on the right side and 25 per cent are at the central position, 25 per cent posterior and one-third at the parasternal foramen. Ninety-five per cent of traumatic hernias are on the left side, and nearly 50 per cent of them are lateral and 25 per cent central. About 50 per cent of the traumatic hernias that occur on the right side are situated centrally. Fifty per cent of bilateral hernias are through the parasternal openings.

St. Luke's Hospital
Chicago 5, Ill.

RETICULO-ENDOTHELIOSIS

HAND-SCHÜLLER-CHRISTIAN DISEASE AND THE RARER MANIFESTATIONS

By WILLIAM S. WALLACE, B.A., M.D., F.A.C.R.

COLORADO SPRINGS, COLORADO

RETICULO-ENDOTHELIOSIS, or hyperplasia of the cells of the reticulo-endothelial system, is an entity occurring sufficiently frequently in general hospital practice to warrant the interest of every clinician. This interest should be increased by the fact that, in many cases, the diagnosis is completely missed during relatively long periods of hospital observation. Further, there are numerous instances in which pathological examination of biopsy or necropsy material is so inconclusive as to be of no actual value. Except in the most clear cut involvement of a characteristic group of organs, as occurs in the Hand-Schüller-Christian variation of this disease, diagnosis is usually only made by the alert roentgenologist and all too frequently his findings are disagreed with by both his clinical colleagues and the pathologists who, however, are never able to substantiate a more tenable diagnosis.

On the roentgenologist's part, diagnosis is made by recognition of entirely typical defects, usually in the membranous bones (Fig. 1), though the long bones may also be involved. The soft tissue changes in reticulo-endotheliosis are far more widespread than those in bone, but unfortunately are not readily demonstrable by roentgen examination as are the bone changes.

Reticulo-endotheliosis is of even greater interest to the roentgenologist because of the fact that the only known satisfactory method of treatment lies in the field of radiation therapy, with quite constant palliation and improvement. There is no other group of diseases in which the roentgenologist is so intimately and essentially concerned with both diagnosis and treatment, though the first description of autopsy findings in a variant member of

the group was made by Hand¹ in 1893 two years before Röntgen's announcement of his discovery.

Hand's original case was complicated by a generalized acute tuberculous infection and was thought to be a manifestation of unusual reaction to the tubercle bacillus, though characteristic lesions were described in the autopsy material, and exophthalmos, diabetes insipidus, and a defect in the right parietal bone were demonstrated in the living patient.

Schüller¹¹ in 1915 described a patient

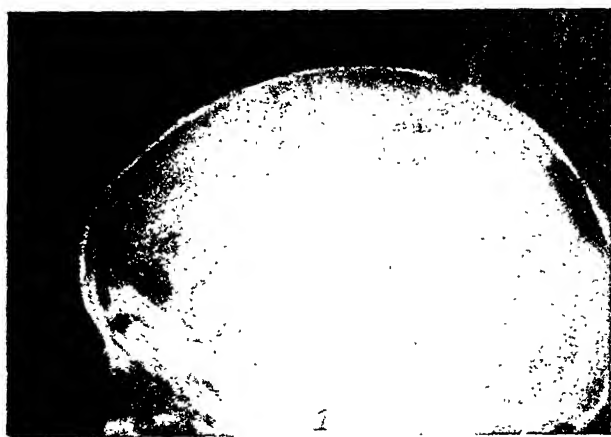


FIG. 1.

presenting unilateral exophthalmos, bony defects in the calvarium, and typical dystrophia adiposogenitalis; also a patient showing exophthalmos, cranial and pelvic bony defects with a healing pathological fracture of the femur, and marked diabetes insipidus. His conclusion was "Anomaly of the skeleton as a result of disease of the hypophysis."

In 1918, Christian² described a patient with a two year progressive history beginning with loosening and decay of the teeth with tender swollen gums, with subsequent exophthalmos, diabetes insipidus,

headache, and gradual loss of hearing, with typical roentgen changes in the cranial and pelvic bones. On comparison of his case with the 2 cases reported by Schüller, Christian concluded that his patient was entirely similar to those of Schüller, and that the findings could be explained wholly on the basis of pituitary dysfunction. For a number of years after Christian's publication, scattered additional cases were described and the hypothesis of a pituitary etiology was widely held.

Rowland,⁹ in 1928, correlated 2 cases of his own with the 12 already reported, and with other cases of lipoid reticulo-endotheliosis and concluded that all were variations of the same clinicopathological entity. This conclusion was reached on the basis of lipid deposit, in all the members of the group, in areas abounding in reticulo-endothelial cells. In individual cases, the extent of deposit in any single location showed a wide variation.

For many years, the curiosity of the histopathologists has been piqued by the presence, the origin, and the function of certain heteromorphic phagocytic cells which lie loosely in the crevices of tissues where they may wander leisurely or whence they may enter the circulating blood stream. These have been variously described⁷ as wandering cells (clasmatocytes), adventitial cells, macrophages, histiocytes, endothelial leukocytes and polyblasts. Recognizing the abundance of these cells in certain specific somatic locations, Aschoff assumed that there is a definite reticulo-endothelial system, with localized collections of these phagocytes, which, as members of the system, he termed reticulo-endothelial cells. Their presence in large numbers in specific locations and their active phagocytic properties are readily proved experimentally by injection into the blood stream of any undissolved material. The largest collections of the reticulo-endothelial cells occur in the sinuses of the spleen, the bone marrow, the lymph nodes, and the lungs. The Küpffer cells of the liver are morphologically and functionally indistinguishable from the free wandering members of the group.

Maximow and Lewis⁶ have observed, *in vivo* and in cultures, the growth and development of these cells from a single small mononuclear structure resembling a lymphocyte to giant multinucleated protoplasmic masses, by the relatively simple processes of splitting and fusing of several, combined with engulfing and ingestion of foreign material.

Although the process of fat metabolism is incompletely understood, it is recognized that many ingested fats pass through the intestinal walls unchanged and enter the blood and lymph streams as undissolved foreign material. As such, they are engulfed by the phagocytes of the reticulo-endothelial system and are found in abundance in the reticulo-endothelial cells. This has been experimentally proved by feeding large amounts of cholesterol to experimental animals. Aschoff assumes that the cells themselves control the deposit of fat within them, and therefore exert a very great influence on intermediary fat metabolism.

Rowland⁹ hypothesized the development of so-called Hand-Schüller-Christian disease in this way: with a hyperabundance of undissolved foreign material in the circulating blood (in this case cholesterol lipids), there is injury of vascular linings with perivascular infiltration with large numbers of phagocytic reticulo-endothelial cells, attempting to remove the irritant material from the circulating blood. The involved areas grow rapidly because of coalescence of adjacent cells and ingestion of smaller or damaged cells by the larger ones. This soon produces capillary delay with subsequent death of additional cells and their consolidation into the phagocytes. New phagocytes constantly arrive in the area via the blood stream, giving rise to the characteristic microscopic arrangement of smaller, newer cells in the center of the lesion near the vessels, with larger cells more full of lipoid material in the periphery. The larger cells, being displaced from their blood supply, frequently undergo aseptic necrosis and are replaced by fibrous tissue, which probably accounts for the microscopic picture of diffuse fibrosis frequently seen

in the more chronic instances of so-called Hand-Schüller-Christian disease.

It is very interesting, at this point, to conjecture whether the improvement seen after radiation therapy in these conditions is not due to intimal damage by irradiation to the capillaries of the region, with a gross diminution in blood supply to the lesions, hastening the process of aseptic necrosis and fibrous tissue replacement.

Wallgren¹⁵ disagreed thoroughly with Rowland's theory of a hypercholesteremia as the primary phenomenon in Hand-Schüller-Christian disease and cites numerous opinions that lipid deposit in the phagocytic cells is a secondary and local phenomenon, and that idiopathic abnormal infiltration of reticulo-endothelial cells is the primary lesion in the disease, with secondary ingestion of blood cholesterol to form typical foam cells in certain organs. As proof, Wallgren points out the characteristic occurrence, in the same patient, of areas of marked reticulo-endothelial proliferation with large numbers of cholesterol-containing foam cells in certain organs, while other organs in the same patient show marked reticulo-endothelial proliferation with complete absence of foam cells. Similarly, hypercholesteremia is not seen in every case of Hand-Schüller-Christian disease and has been described in other cases of reticulo-endotheliosis in which there is no lipid storage. Both of these facts seem to indicate that hypercholesteremia, when present, results secondarily from proliferation of reticulo-endothelial cells. One of the cases to be cited later by the author showed a terminal hypercholesteremia after a more or less typical chronic non-lipoid reticulo-endotheliosis became suddenly acute, with fulminating liver involvement.

Wallgren further disagrees with the time-honored hypothesis that classifies Hand-Schüller-Christian disease as a xanthomatosis belonging to the group of lipid-storage diseases, including Gaucher's and Niemann-Pick's disease, and xanthelasma, chiefly because of the fact that, in the true xanthomatoses, a quantitative increase in the stored material is always demonstrable

in the blood and non-involved tissues, whereas hypercholesteremia is definitely an inconstant finding in Hand-Schüller-Christian disease. His conclusions are substantiated by very extensive investigation by a number of different workers.

Abt and Denenholz¹ have reviewed a number of cases of an obscure acute disease occurring in infants and young children, usually rapidly fatal, characterized by generalized reticulo-endothelial hyperplasia. They found, in some cases, an acute infection which could be regarded as the factor responsible for the great increase in cells of the reticulo-endothelial system. In other cases, there was no evidence of an etiologically significant infectious process. This latter group of cases, they identified as Letterer-Siwe disease, in honor of its earliest investigators.

Letterer-Siwe disease is characterized, according to Siwe¹² by: (1) splenomegaly and hepatomegaly; (2) hemorrhagic diathesis; (3) generalized non-infectious lymphadenopathy; (4) progressive secondary anemia without leukocytosis; (5) occurrence in infants and young children, fatal prognosis, and variable duration; (6) localized skeletal changes, and (7) generalized reticulo-endothelial hyperplasia without constant storage of lipid material. Wallgren denies the existence of a clinical entity of infectious non-lipoid reticulo-endotheliosis, claims that in all reported cases any associated infection is merely concurrent, and that all the evidence is to the effect that the so-called infectious and non-infectious (or Letterer-Siwe) types are identical.

Wallgren further points out that the stage of development in either Schüller-Christian or Letterer-Siwe disease largely determines the question of cholesterol deposit in the hyperplastic reticulo-endothelial cells. He interprets the well known facts of foam cell formation in some organs while others are not affected, and the change in the histopathologic picture in individual cases during the course of a protracted disease, when non-lipoid reticulo-endothelial hyperplasia may be present at biopsy with typical foam cell

formation at necropsy, and when areas showing typical foam cells at biopsy subsequently show fibrous tissue scarring, as indicating that there is a single disease, namely reticulo-endotheliosis. If it starts in infants or very young children, the typical fulminating course of Letterer-Siwe disease is the characteristic sequence of events, and, in older individuals, the characteristic protracted course is seen, with much less prominent symptoms, and possibly secondary cholesterol deposit in foam cells in any involved organ.

The pathological findings vary only in the presence or absence of stored cholesterol—the types of cells which become hyperplastic are identical in the two conditions, the locations of the deposits of hyperplastic reticulo-endothelial cells are likewise identical, and the resulting symptoms and findings are so much alike that the two diseases in varying forms cannot always be distinguished. Though Letterer-Siwe disease, in every reported case, has run a rapidly fatal course, there are many cases of Hand-Schüller-Christian disease running a subacute course rather than the typically described chronic course and there are cases in the literature varying all the way between the two.

There is so much clinical, pathological, and reasonable evidence in favor of Wallgren's stand that it seems highly probable to the author that there is one pathological condition of reticulo-endothelial hyperplasia, its findings modified by age of the individual, organ or area of deposit of hyperplastic cells, and by some other factor of repair, as obscure as the factor causing original reticulo-endothelial hyperplasia.

It seems highly logical to suggest that cholesterol deposit, with production of foam cells which become immobilized reservoirs, is a reparative attempt on the part of the organism as a whole to counteract the unbridled production of reticulo-endothelial cells. The immobilized reservoirs frequently are located in areas not too significant or important to the physiology of the individual as a whole. Along this line, in

Letterer-Siwe disease, the power to immobilize these hyperplastic cells by lipoid deposit within them, would seem to be lacking in the very young. Conversely, as would seem the case in 2 of my patients, after a protracted course, for some unknown reason, probably fatigue, this reparative ability is lost, and generalized involvement and infiltration of vital systems follows rapidly, with inevitable results. Similarly, in cases of Hand-Schüller-Christian disease which are not fatal, this reparative process of cholesterol storage and immobilization of reticulo-endothelial cells may continue as long as the reticulo-endothelial system is stimulated to hyperactivity—once the hyperplasia stops, the cholesterol is absorbed and the deflated cells are replaced by fibrous tissue.

Gross and Jacox³ have reported at length on the striking anatomical, histopathological, symptomatic and roentgenological similarity between so-called eosinophilic granuloma and the described types of reticulo-endotheliosis, and have concluded that eosinophilic granuloma is another reticulo-endotheliosis with a tendency to predominant hyperplasia of the eosinophilic elements, and a usually solitary bone lesion, though much soft tissue involvement may be present and undiscovered. No autopsies have been reported on patients with eosinophilic granuloma.

It is of particular interest that one of my cases, with multiple bone lesions, had a biopsy diagnosis of eosinophilic granuloma. This patient's history extended over almost three years, and there were associated findings of a moderate anemia, generalized lymphadenopathy, and malnutrition and delayed development.

The experimental work along the lines of reticulo-endotheliosis is meager but most suggestive in its implications. Rowland¹⁰ quotes the artificial production from reticulo-endothelial cells of typical xanthoma cells, in rabbits, by Anitschkow and Chaladow, following high cholesterol diets. Sosman¹³ quotes further independent work by Yuasa, feeding cholesterol to higher

animals, with the same results. Much more recently, Muyaji⁸ has shown, with rabbits, that hypercholesteremia alone will not cause lesions comparable to lipoid granulomas. Artificially produced inflammatory granulomas show a tendency to small deposits of cholesterol, which are incomparably greater in the presence of hypercholesteremia.

Sosman,^{13,14} Kennedy,⁵ and Gross and Jacox,³ in subsequent studies of their own and many other patients, have pointed out that many symptoms and findings are compatible with the diagnosis of Hand-Schüller-Christian disease; that not all are found uniformly; and that not even Christian's triad of skull defects, exophthalmos, and diabetes insipidus is found in every case. This is readily explained by the concept of chance deposit of large numbers of reticulo-endothelial cells in various locations.

I have been very fortunate in seeing 7 patients showing more or less typical skull defects. The only other common findings in all the cases were slight eosinophilia and moderate anemia. There was no apparent influence of age or sex, but 2 patients with rather typical Hand-Schüller-Christian disease were Mexican, and the single Negro patient showed skin lesions. None of the patients showed any marked hypercholesteremia at first admission, though one who died an acute death with liver involvement showed a very high cholesterol value terminally. The majority of the patients showed defects in bones other than the skull, especially mandible and maxilla, diabetes insipidus of varying degree, gingivitis, growth delay, and malnutrition. The less frequently occurring findings included exophthalmos, jaundice, aural discharge, generalized lymphadenopathy, hemorrhagic diathesis, skin lesions, and a variety of intercurrent conditions. Hepatosplenomegaly was not a prominent feature.

None of my cases came to autopsy, but it is extremely interesting that, in the 5 cases where satisfactory biopsy was obtained, there were two positive pathological diag-

noses of Hand-Schüller-Christian disease, one of eosinophilic granuloma, and two perfect descriptions of reticulo-endotheliosis without characteristic lipoid deposit and foam cell formation.

All but one of the cases have received roentgen therapy under my direction, with varying results.

CASE REPORTS

Case 1. F.C.B. This white male, aged twelve, was admitted to John Sealy Hospital, Galveston, Texas, on December 19, 1942, with a chief complaint of a painful swelling behind the right ear, present for four months. Additional complaints were discharge from the right ear for two months, and loose lower teeth, also for two months.

The parents stated that this was their twelfth child, that he had suffered the usual childhood diseases, and that his development and growth had been perfectly normal for his first eight years. At the age of eight, they began to notice polydipsia and polyuria, and failure to grow and gain weight. At that time, there was a non-tender swelling on the vertex, which subsided spontaneously. During the past four months before admission, he had lost 20 pounds.

Physical examination showed: (1) a hot tender swelling over the right mastoid region; (2) loose dirty teeth with gums draining purulent material; (3) palpable defects in the right parietal bone; (4) draining right ear; (5) emaciation; (6) stomatitis with a raw, cracked tongue.

Laboratory findings were: (1) urine, specific gravity of 1.002 to 1.006; (2) leukocytosis of 14,000 with 3 eosinophils per field; (3) anemia of 3,800,000, with 73 per cent hemoglobin; (4) *Necator americanus* in the stool; (5) slight elevation of the glucose tolerance test.

On admission, sulfanilamide was started by mouth, and a total of 9.5 grams was given, without significant change. On December 21, 1942, a complete right mastoidectomy failed to reveal any infected material, and the mastoid cells were seen completely replaced by a reddish-gray tumor mass. Tissue specimens unfortunately were autolyzed by the time they were examined. After two postoperative blood transfusions, irradiation of the skull was started on December 24, 1942.

Roentgenograms of the skull showed, on admission, a large irregular punched-out defect in the right mastoid region, and multiple similar



FIG. 2. Case 1. Roentgenogram of the skull. Note parietal and occipital defects.

defects in the right parietal bone (Fig. 2). Roentgenograms of the right mandible showed marked excavation about all the roots of the teeth (Fig. 3). In none of the lesions was there any evidence of any new bone formation. The diagnosis given was "Schüller-Christian disease." Between December 24, 1942, and January 4, 1943, a total of 1,000 r, measured in air, was given to each of two 10 by 10 cm. fields, in the temporoparietal regions, at 217 kv. (peak), constant potential, 18 ma., 50 cm. skin target distance, using filtration of 1 mm. copper and 0.5 mm. aluminum, with a half-value layer of 1.5 mm. copper.

The patient remained in the hospital, showing daily improvement in all his findings, except the diabetes insipidus, with daily intake and output of about 8,000 cc.

A secondary closure of the right mastoidectomy was done on February 2, 1943.

On February 25, 1943, there was a generalized exacerbation of all the symptoms, with several new areas appearing in the left side of the skull, increase in intake and output, pain in the jaws, and pain in the right mastoid region.

Between March 2 and March 6, the patient was given another 750 r to each of the two temporoparietal fields, including the mandible, using the factors described above.

Following this additional therapy, there was marked improvement, with regression of all the symptoms, and the patient left the hospital on March 27, 1943.

Between March 27 and May 6, patient re-

mained at home with decreasing polydipsia and polyuria and few other symptoms except difficulty in eating due to the sore, loose teeth. Diplopia was experienced on one occasion, and there was a complete temporary alopecia.

The patient was re-admitted on May 6 with another acute exacerbation. There were no significant differences, on physical examination, from the findings on previous admission. Several loose teeth were removed.

Between May 12 and May 17, a total of 500 r was given to each of the lateral skull fields, using the same technique as described above, and patient was discharged slightly improved on May 22, 1943.

Roentgenograms made just before discharge showed no change in the appearance of the cranial and mandibular lesions. There were two admissions, from June 20 to June 30, and July 4 to July 5, for treatment of stomatitis and removal of additional teeth. Intake and output had dropped to about 2,000 cc. and no additional skull lesions had appeared. The patient has not been seen since July 5, 1943.

Comment. Most striking in this patient were the absence of exophthalmos, the marked stomatitis most probably due to a



FIG. 3. Case 1. Right mandible.

deficiency state, and the striking improvement and relief of symptoms following the second and third courses of radiation therapy. The intercurrent *Necator americanus* infestation may be responsible for the eosinophilia demonstrated.

CASE II. F. L. This white male, aged three, of Mexican extraction, was admitted to John Sealy Hospital June 20, 1942, complaining of a tumor on the head which had appeared after a fall out of bed three months previously. Questioning of the parents revealed definite polyuria and polydipsia, which they had not noticed, present for the same length of time. The parents stated that this was their eighth child, and that he had developed normally, except for an attack of whooping cough complicated by pneumonia. Both parents had received irregular and inadequate antiluetic therapy.

Significant physical findings were only: (1) two soft, semifluctuant, non-tender masses, each about 4 cm. in diameter, in the right frontoparietal regions; (2) palpable defects in the calvarium, showing under-cut edges, beneath the soft tumor masses.

Significant laboratory findings were: (1) urine, specific gravity of 1.001 to 1.010; (2) four eosinophils per high power field; (3) anemia of 4,000,000 with 80 per cent hemoglobin; (4) 4 plus Kahn and Wassermann reactions.

During the hospital stay, intake and output averaged about 2,000 cc.



FIG. 4. Case II. July 3, 1942.



FIG. 5. Case II. December 10, 1944.

On December 18, 1942, biopsy of the cranial mass was reported by Dr. Paul Brindley, as follows: "There is a loose tissue of mononuclear cells intermixed with multinucleated giant cells. Practically all the cells show a foamy cytoplasm and in some the cytoplasm contains granules of light yellow pigment. The mononuclear cells are round, ovoid, and fusiform, with variable sized nuclei. Little or no mitosis is seen. Many cells are enormously distended with lipid material, with crowding of their nuclei to the periphery. . . . This appears to be lipid dystrophy, corresponding to Schüller-Christian disease."

Admission roentgenograms of the skull showed the two punched out defects in the right frontal and parietal bones as palpated (Fig. 4). The other bones showed no comparable change. Roentgen diagnosis of Schüller-Christian disease was made on the basis of the skull films, and the diabetes insipidus.

Between July 3 and July 10, 1942, a total of 900 r, measured in air, was given to each of two frontoparietal fields, 7 by 14 cm., at 152 kv. (peak), constant potential, 20 ma., 20 cm. skin target distance, using filtration of 1 mm. copper and 0.5 mm. aluminum, with a half-value layer of about 1 mm. copper.

During the hospital stay, intake and output remained at about 2,000 cc. after this course of therapy.

The patient remained in the hospital for some time, and between September 2 and September 16, 1942, he received another 1,200 r to each of the cranial fields, using the same technique. Roentgenograms taken at discharge, on October 3, showed slight new bone formation in the cranial defects. Additional roentgenograms taken on February 10, 1944 (Fig. 5), courtesy of Dr. B. M. Works, of Brownsville, Texas, showed practically complete filling in of the areas in the right frontoparietal region with new bone. Communication from the parents stated that the diabetes insipidus was very much improved, and there were no other new complaints.

Comment. This was the only patient in this series showing the defects confined to the cranial bones. The history of trauma in relation to the bony defects can be disregarded for obvious reasons. There were fewer signs and symptoms in this case than any of the others, yet the pathologist was unhesitant in confirming the roentgen diagnosis. The presence of congenital lues did not seem to interfere in any way with healing of the cranial lesions after radiation therapy.

CASE III. D. A. This white female, aged four, was admitted to John Sealy Hospital September 12, 1945, with a chief complaint of "boils on the neck and head." The parents stated that these swellings had first appeared behind the ears three years previously. For one year,

the swellings slowly increased in size, gradually becoming very painful to touch. They interfered with movements of the patient's head. There was no drainage.

The local physician gave an unknown amount of roentgen therapy to the mastoid areas, and the child returned to apparently normal health for a period of six months. At that time, the patient began to lose weight and become apathetic and showed no interest in play. She began to have difficulty rising from a sitting position or getting out of bed. Shortly thereafter, the generalized symptoms were spontaneously relieved, and peculiar tumor masses appeared over the left eye and in the left parietal region. The masses were soft, almost fluctuant, and non-tender. An unspecified amount of roentgen therapy was given with little or no improvement. Penicillin injection also produced no change.

One month before admission, worm infestation was found and the patient was given two courses of vermifuge.



FIG. 6. Case III.

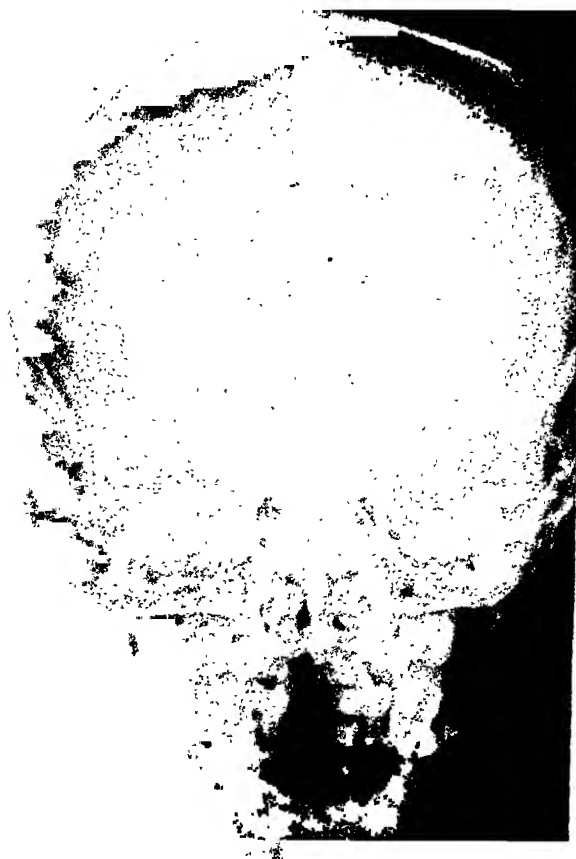


FIG. 7. Case III.

Significant physical findings were: (1) cachexia and emaciation; (2) head louse infestation; (3) drainage sinus in left parieto-occipital region; (4) generalized firm, non-tender lymphadenopathy; (5) 2 by 5 cm. soft lesion at base of skull; (6) depressed, round 3 cm. lesion left frontal bone; (7) draining sinus at vertex; (8) loose carious teeth; (9) systolic apical murmur.

Significant laboratory findings were: (1) anemia of 3,900,000 with 76 per cent hemoglobin; (2) leukocytosis of 9,700 with 2 per cent eosinophils; (3) bone marrow was somewhat hypercellular with relative increase in eosinophils and lymphocytes. No foam cells were seen.

Positive roentgen findings were: (1) Skull showed punched out typical lesions in both parietal bones, frontal bones, and occiput (Fig. 6 and 7). (2) Pelvis showed large punched out areas in the wing of each ilium. (3) The lumbar spine showed partial collapse of the first lumbar body, with marked condensation of bone (Fig. 8).

Biopsy diagnosis, on one of the parietal lesions, was "Eosinophilic granuloma, characterized by proliferation of large numbers of small round cells and a few multinucleated cells and large amounts of reticulin fibers."

Between October 4 and October 16, 1945, a total of 800 r, measured in air, was given to each of two parietotemporal fields, 10 by 10 cm., and a total of 1,000 r to each of two anterior pelvic fields, 10 by 15 cm. The factors were 217 kv. (peak), constant potential, 18 ma., 50 cm. skin target distance, using filtration of 0.75 mm. copper and 0.5 mm. aluminum, with a half-value layer of 1.2 mm. copper.

The patient remained in the hospital, showing only slight improvement.

Between November 26, and December 1, 1945, 600 r was given to each of two lateral lumbar fields, 10 by 10 cm., using the factors described above. Between January 7 and January 12, 1946, this last course was repeated, using the same factors.

Patient was discharged from the hospital January 12, 1946, and has not been seen since that time. Roentgenograms at the time of discharge showed no significant evidence of healing of any of the bone lesions.

Comment. This was one of the two patients who did not show diabetes insipidus as a presenting feature, but she had very widespread bone lesions, and was the only

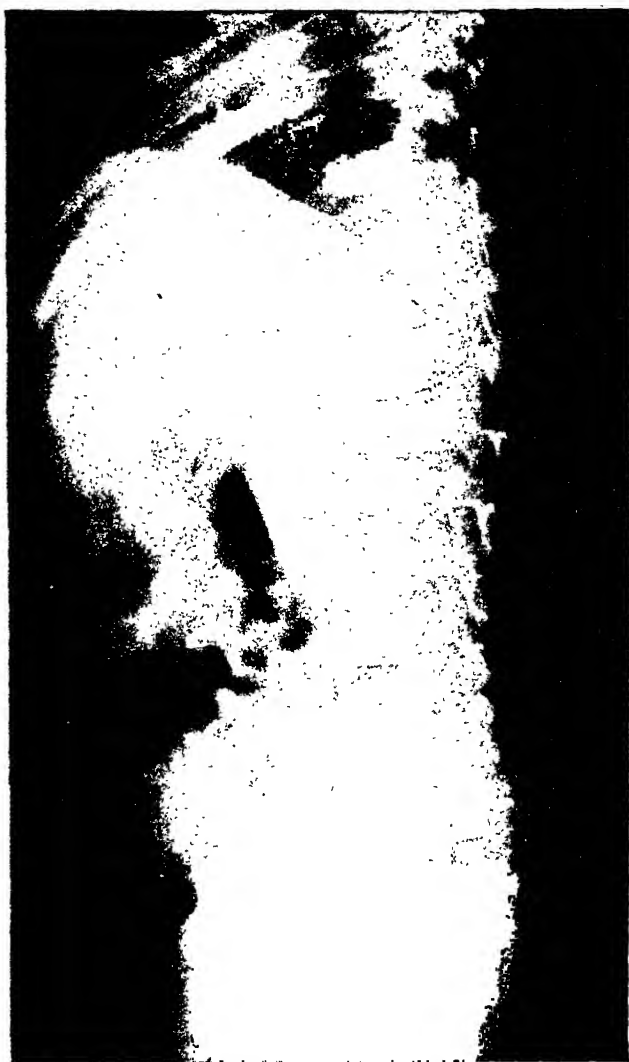


FIG. 8. Case III. Collapsed first lumbar body.

case showing involvement of a vertebral body. The course of the disease was undoubtedly altered to some extent by the unknown quantity of roentgen therapy given prior to our observation. Insufficient time has elapsed to evaluate the effect of adequate therapy. The biopsy diagnosis of eosinophilic granuloma is very interesting.

CASE IV. F.N.H. This white male, aged four, was admitted to John Sealy Hospital July 27, 1939, with a chief complaint of fracture of the right humerus, present for three days. The parents stated that polydipsia and polyuria had been present for three years, and that for the same length of time they had noticed knots and depressed areas on his head. The right hip had been painful for about one year.

Two years previously, the patient had been under the care of Dr. H. H. Ogilvie, of San



FIG. 9. Case IV. Involvement of right humerus with pathological fracture.

Antonio, Texas, who had done a biopsy of a scalp lesion with the report "multiple myeloma of the bone." Aside from the scalp lesions and a destructive process in the left ninth rib and mandible, all found by roentgen examination, Dr. Ogilvie's findings were normal, except for an anemia of 3,330,000 with 41 per cent hemoglobin, and a leukocytosis of 15,850.

Scattered roentgen treatments were given between March 25 and June 11, 1937, using an unspecified amount of radiation. On July 26, 1937, the patient developed a staggering gait and a medial rotation of the left eye, and it was suggested that there was involvement of the vestibular apparatus. Blood count at this time showed slight improvement in the anemia, with 51 per cent hemoglobin, and showed 2 per cent eosinophils for the first time.

The patient was taken to the Mayo Clinic, where he was under the care of Dr. R. L. J. Kennedy and, during several admissions, received a large amount of roentgen therapy,

with the last treatment in October, 1938. At the Mayo Clinic, the case was diagnosed as xanthomatosis.

There was nothing of significance in the other past or family history.

Three days before admission to John Sealy Hospital, the boy fell while playing and fractured his right humerus.

On admission, significant physical findings were: (1) fractured neck of right humerus; (2) marked malnutrition; (3) three depressed areas in calvarium; (4) marked exophthalmos; (5) small tumor outer canthus of right eye; (6) many teeth out, remaining ones loose.

Significant laboratory findings were: (1) urine, specific gravity of 1.005; (2) intake and output of around 2,300 cc. per day; (3) anemia of 3,600,000; (4) blood cholesterol of 222.

Roentgenograms of the entire skeleton showed cystic areas of destruction in the lower end of the left femur, both ends of the right tibia, in the skull, in the upper end of the right humerus, with a pathological fracture. Lesions were also seen in the upper end of the right femur, and in both innominate bones. The roentgen diagnosis was Schüller-Christian disease.

The patient was discharged from the hospital August 24, 1939, to receive radiation therapy as an out-patient.

Unfortunately our original roentgenograms of the skull were sent away for comparison and have been lost. Figure 10 was made during this admission.

Between September 20 and October 24, 1939,

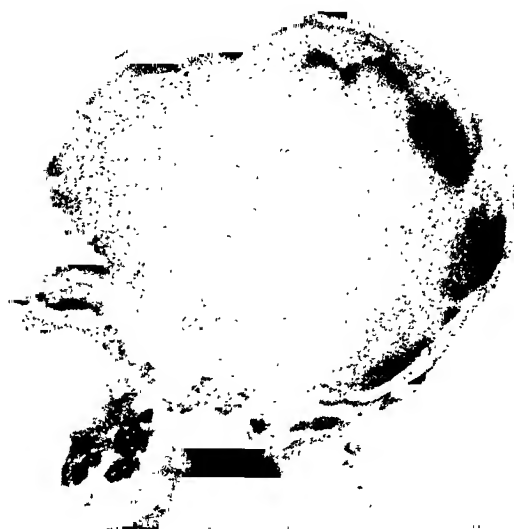


FIG. 10. Case IV. September 9, 1940.

the patient was given 1,000 r to the right orbit, 750 r to the upper end of the right tibia, 750 r to the lower end of the left femur, 600 r to the right humerus, and 500 r to each of two parieto-occipital fields. The field sizes varied, all dosage was measured in air, and the radiation was given at 200 kv. (peak) (mechanically rectified), 5 ma., and 50 cm. skin target distance, using filtration of 0.5 mm. copper and 1 mm. aluminum. Between November 22, 1939, and January 29, 1940, the patient was given 1,000 r to the right orbit, 750 r to the right upper femur, and 1,150 r to the left upper femur, using the same factors. May 7 to 14, 1940, an additional 750 r was given to the left parietal bone, and



FIG. 11. Case IV. Roentgenogram of pelvis September 9, 1940, showing multiple punched-out lesions.

August 5 to August 15, 1940, an additional 800 r was given to a single occipital field.

Patient was readmitted to John Sealy Hospital on September 9, 1940, complaining of pain in the back and epigastrium, radiating to the left shoulder, present for three days, with epigastric swelling and frequent epistaxis. Figure 10 shows the skull at this time, Figure 11 the pelvis, and Figure 12 the right tibia.

Physical examination showed significant findings of: (1) malnutrition; (2) moderate icterus; (3) depressed areas in the skull; (4) loss of many teeth and the right lower alveolar ridge; (5) generalized lymphadenopathy; (6) a reddish-yellow scaly plaque, 2 by 3 cm., on the posterior aspect of the right shoulder.

The pain slowly subsided and patient was discharged October 14, 1940, without additional radiation therapy.

The patient was seen periodically as an out-

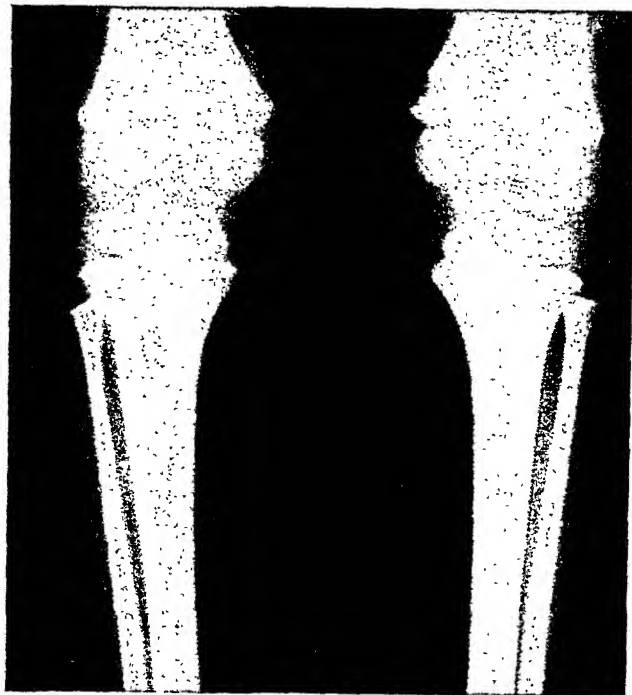


FIG. 12. Case IV. Roentgenogram of right tibia, September 9, 1940, showing solitary lesion.

patient, and for four months all of the symptoms were markedly alleviated.

The patient returned on February 7, 1941, with a marked increase in intake-output figures, to around 4,000 cc. He was treated as an outpatient, and between February 7 and April 9, 1941, received a total of 350 r to the right parietal bone, 600 r to the left parietal bone, 600 r to the right frontal bone, 400 r to each side of the occiput, 400 r to the right upper humerus, and 400 r to the region of the left hip. The same factors stated above were used.

The patient was readmitted to the hospital on November 3, 1941, with complaints of con-



FIG. 13. Case IV. November 3, 1941. Cranial lesions unchanged or larger.

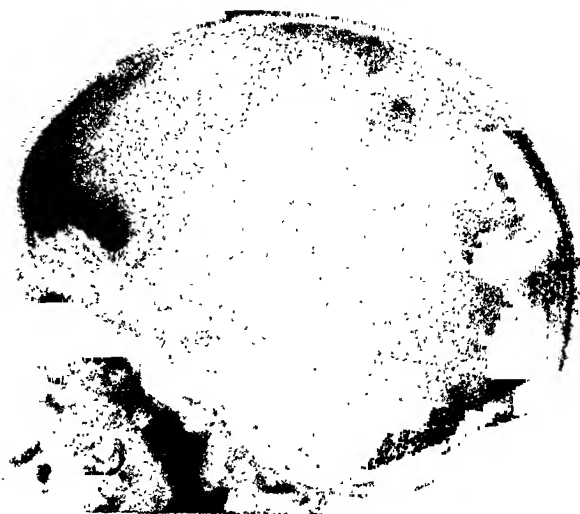


FIG. 14. Case IV. January 25, 1946.

tinued epistaxis, slightly increased diabetes insipidus, and persistence of the plaque on the right shoulder. The exophthalmos and the areas in the skull were considered to be unchanged (Fig. 13).

Significant laboratory findings were: (1) 5,000,000 red blood cells; (2) 3 per cent eosinophils in the white blood cell count (differential); (3) occult blood in the stools; (4) blood cholesterol of 267.

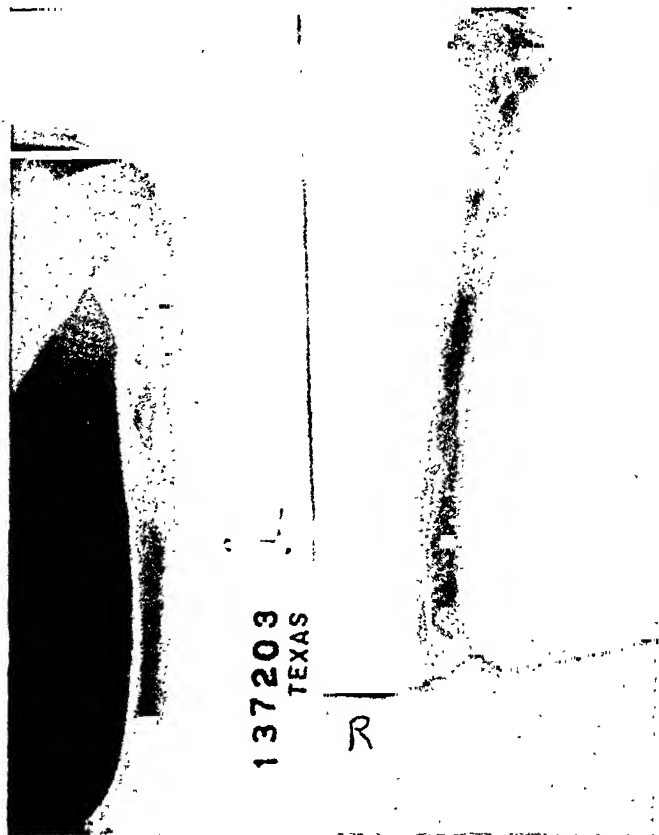


FIG. 15. Case IV. Right humerus, January 25, 1946.

The patient was discharged without treatment.

The next return to the clinic was on July 22, 1943, at which time there was a traumatic fracture of the right clavicle, and no other new complaints. The plaque on the right shoulder had disappeared, and the fractured right humerus was well healed.

Between July 26 and August 6, 1943, he was given a total of 450 r to each of the temporo-parietal regions, using 217 kv. (peak), 18 ma., 50 cm. skin target distance, and filtration of 1 mm. copper and 0.5 mm. aluminum.

The next hospital admission was between



FIG. 16. Case IV. Pelvis, January 25, 1946.

November 28 and December 8, 1945, with complaint of pain in the lumbosacral region and left hip, increased by motion. Roentgenograms showed no new pathological changes in the region. There was a slight anemia of 4,600,000 and 2 per cent eosinophils were found in the differential count. There was a faint icteric tint to the skin, with a slightly positive direct Van den Berg reaction, and icterus index of 7.6. It was decided to run a vitamin A absorption test, and this was done by the courtesy of the Strong Memorial Hospital, Rochester, N. Y. The patient was given 7,000 International Units of vitamin A per kilo for a total of 157,000 units, and the vitamin A content of the blood serum was measured at four and seven hours, as well as the content before administration of the vitamin. The fasting sample showed a value of

10 (normal about 25)—at four hours, the value was 532 (normal about 250)—and at seven hours the value was 61 (normal about 140). The test seemed to indicate a vitamin A deficiency, with the vitamin being removed from the circulating blood more rapidly than normal.

The most recent hospital admission was between January 17 and January 25, 1946. There were no new complaints or findings, the differential count showed 5 per cent eosinophils, and there was a slight anemia of 4,550,000. On January 17 and 19, the patient was given 500,000 units of vitamin A by mouth. Roentgen examination of all the bones showed little or no change from the previous study (Fig. 14, 15 and 16).

Comment. This most spectacular patient has, over ten years of observation, exhibited every finding that has been described for Hand-Schüller-Christian disease. He illustrates very clearly the occurrence of spontaneous remissions, with no new bone lesions in the past five years. His growth has been markedly retarded and his present appearance is that of a withered and shrunken old man.

The massive amount of radiation has been given quite irregularly because of difficulty in following the patient, as the family is migrant. Perhaps the irregularity of the irradiation is the reason for only slight healing of the skull lesions over a period of years.

Mentally this patient is far above average. His intake and output seem fairly stationary at about 4,000 cc. It is to be hoped that significant improvement will follow the massive dosage of vitamin A. He will be followed as long as possible.

CASE V. E.L., female, white, aged nineteen, unmarried, was admitted to John Sealy Hospital on March 21, 1942, with the chief complaints of deafness and amenorrhea, stating that she had never menstruated.

She had been under the care of her local doctor for three years, for excessive urination. A diagnosis of diabetes insipidus had been made, and the condition was well controlled with intranasal application of Armour's pituitary powder.

In August, 1941, she had an acute attack of bilateral mastoiditis, and a bilateral simple

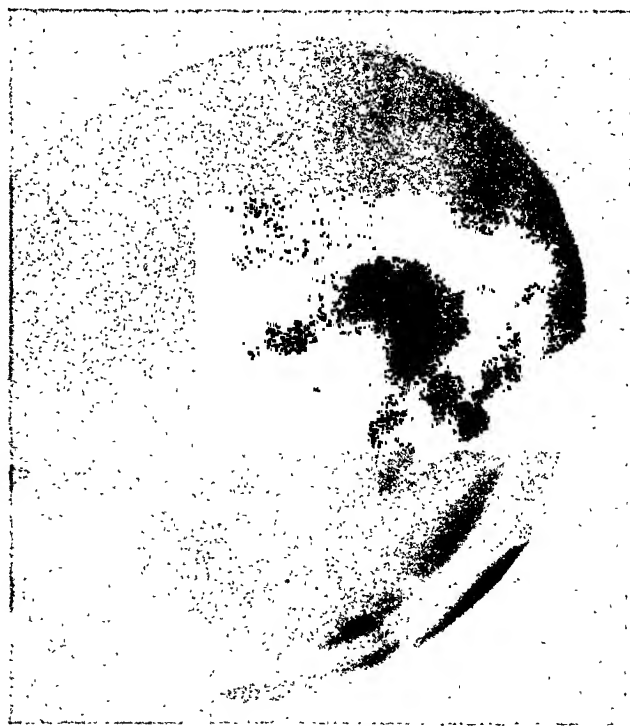


FIG. 17 and 18. Case v. March 23, 1942.

mastoidectomy was performed. No typical destructive process with suppuration was found, but there was extensive destruction of the mastoid processes by a peculiar grayish-red tissue.

Significant physical findings at admission were: (1) bilateral deafness; (2) infantile breast development; (3) absence of axillary and pubic hair; (4) bilateral mastoid scars; (5) infantile development of cervix and uterus; (6) dizziness and positive Romberg sign.



FIG. 19 and 20. Case v. June 30, 1942. Note extensive mandibular destruction.

The only significant laboratory finding at admission was a basal metabolic rate 20 per cent below normal.

Roentgenograms of the skull, taken March 23, 1942 (Fig. 17 and 18), showed extensive destruction in both mastoid processes, with extension to the temporal and parietal bones above and behind. There was seen to be extensive bone infection beyond the limits of destruction. Extensive bone erosion was also seen at the angles of both mandibles.

Roentgenograms of the long bones showed slight retardation of epiphyseal development, but no evidence of localized destructive lesions. Roentgenograms of the teeth showed a few areas of deep pyorrheal erosion. Spinal encephalogram on May 1, 1942, showed good filling of the ventricular system, and no significant deviation from a normal appearance.

Secondary mastoidectomy was performed on

May 17, 1942, with an uneventful convalescence. The same peculiar appearing tissue was found, the pathological report being as follows: "Section of bone, the marrow of which is infiltrated by a number of fibroblasts and large cells with voluminous vesicular cytoplasm. There is little myeloid tissue, and a few lymphocytes, neutrophils, and plasma cells are present."

Patient went home for two weeks, and returned to the hospital June 30, 1942, remaining until July 19, 1942.

During this stay, a revision of the mastoidectomy and a sequestrectomy of necrotic bone from the mastoid areas were done; many teeth became loose, and several were lost. Roentgenograms of the mandible (Fig. 19 and 20) showed extensive destruction of the alveolar ridge of the mandible, bilaterally, with only a thin strip of the lower border of the mandible remaining.

On the next return, patient was in the hospital from July 26 to August 15, 1942, and the roentgenologist finally arrived at a diagnosis of a Schüller-Christian-like syndrome, on the basis of the bone destruction in mandible and skull, loosened teeth, diabetes insipidus, and the pituitary lesion evidenced by the presence of Froehlich's syndrome.

Between August 4 and August 15, 1942, she was given a total of 1,500 r, measured in air, to each of two temporoparietal fields, including the mastoid regions and mandible, each 10 by 10 cm., at 217 kv. (peak), constant potential, 18 ma., and 50 cm. skin target distance, using filtration of 1 mm. copper and 0.5 mm. aluminum. After discharge, several letters stated that she was doing better than she had done for over a year.

She was readmitted on September 30, 1944, with the chief complaint that, for the past two weeks, her skin had been turning yellow, the stools had been clay-colored, the urine was a dark smoky color, and there had been intense widespread pruritus.

Significant physical findings were: (1) Intense jaundice of skin and conjunctivae; (2) all the previous findings.

Significant laboratory data were: (1) eosinophilia of 11 per cent in the differential count; (2) bilirubinuria; (3) acholic stools; (4) icterus index of 140; (5) direct Van den Berg with quantitative of 48 mg. per cent; (6) blood cholesterol of 278.

The previous course of irradiation to the

skull and mandible was repeated between October 8 and October 17, 1942. Supportive therapy with parenteral fluids and vitamin K showed no improvement in the deepening jaundice.

On November 2, 1942, the icterus index was 145 and the blood cholesterol was 345. On November 5, 1942, the icterus index was 178 and the blood cholesterol value was 480.

On November 27, 1942, exploratory laparotomy by Dr. E. J. Poth showed a large tumor of the head of the pancreas, completely obstructing the flow of bile. Biopsy of the pancreas was reported as showing no evidence of malignancy, only chronic pancreatitis and chronic hyperplastic lymphadenitis. Before closure, a cholecystojejunostomy and jejunojejunostomy were done in an effort to sidetrack the bile flow.

Postoperative course was slowly retrogressive, and, in spite of chemotherapy and supporting treatment, death occurred on December 14, 1942.

No autopsy was obtained.

Comment. This patient showed findings very similar to those of Schüller's first case, except for exophthalmos. Her disease had apparently originated about the time of puberty, giving rise to Froehlich's syndrome, and had progressed only very slowly till the terminal period of nine months, during which it became subacute. The obstructive jaundice, due to benign proliferation in the head of the pancreas, puzzled all observers both before and during the laparotomy. This was the only patient in this series to show a significantly elevated blood cholesterol value, and then only after biliary obstruction was practically complete. The author feels remiss that he did not make a correct diagnosis on the first roentgen examination of mastoids and mandible.

This patient showed less response to radiation therapy than any member of the group. It would have been desirable to irradiate the region of the head of the pancreas, after exploration, but opportunity for this was not available. It is regrettable that necropsy was omitted.

CASE VI. This female, white, aged thirty-seven, married, was admitted to John Sealy Hospital August 11, 1942, partially comatose

and disoriented. The family stated that she had first noticed left frontal headaches, which were steady and persistent, two years before, at which time she was pregnant. These persisted for about six months till the spontaneous delivery of her fourth child. At the time of this spontaneous delivery, patient had a convulsion, and the left eye suddenly became proptosed. Following this, there were recurrent convulsions at frequent intervals, and the patient became progressively disoriented, somnolent, and finally almost comatose. For three months before admission, there was complete incontinence of urine and feces. The family doctor told the family that she was crazy and advised them to bring her for hospitalization.

On admission, significant physical findings were: (1) coma; (2) incontinence of urine and feces; (3) left exophthalmos; (4) flexion contractions of the extremities.

Significant laboratory findings were: (1) anemia of 4,000,000; (2) 4 per cent eosinophils in the differential count; (3) blood cholesterol of 182.

Roentgenograms of the skull showed characteristic punched-out defects on both sides of the frontal bone, in the midline, with erosion of the roof of the left orbit. There were also large areas of erosion about the roots of the molar and premolar teeth (Fig. 21 and 22). A diagnosis of xanthoma of the frontal bones and mandible, of the Schüller-Christian type, was made.

Between August 17 and August 28, 1942, a total of 1,500 r, measured in air, was given to each of two 10 by 10 cm. frontal fields, at 217 kv. (peak), constant potential, 18 ma. and 50 cm. skin target distance, using filtration of 1 mm. copper and 0.5 mm. aluminum. During the course of treatment, the patient showed rapidly advancing clinical improvement, with orientation, return of sphincter control, and assumption of an interest in things about her.

It was decided, after the improvement had become stationary to do an exploratory operation and establish a definite diagnosis. On September 24, 1942, Dr. S. R. Snodgrass did a left frontal craniotomy, exposing a firm of pinkish-brown tumor in the subdural space, extending to the midline, fusing with the falx, invading a tributary vein of the sagittal sinus, extending down along the anterior and inferior surfaces of the left frontal lobe, with a large dense mass on the roof of the left orbit. Biopsy specimen was taken, and closure effected.

Biopsy report, by Dr. Paul Brindley, was:



FIG. 21 and 22. Case VI. August 11, 1942. Extensive defects in the frontal bone and mandibular absorption.

"Very cellular tissue with reticular ground substance. Some mitoses. Cells are very pleomorphic. Small cells with round nuclei predominate. Some fresh blood and scanty reticulum (solid tumor mass). Other sections

show a membrane with papilliform folds lined with cells. Within the membrane there are fibroblastic cells as well as many of the small cells with round nuclei. Reticulin stain shows abundant fibrils. Vessels are fairly frequent. Conclusion: Diffuse cellular tumor, growing fairly rapidly. No definite classification of the histogenesis of this growth."

The postoperative course was uneventful, with continuing general improvement.

Between October 5 and 17, 1942, an additional 1,500 r, measured in air, was given to each of the two frontal fields, using the factors described above.

The patient remained at home till June 8, 1943, living a relatively normal life, able to do her own housework, but during the interval she

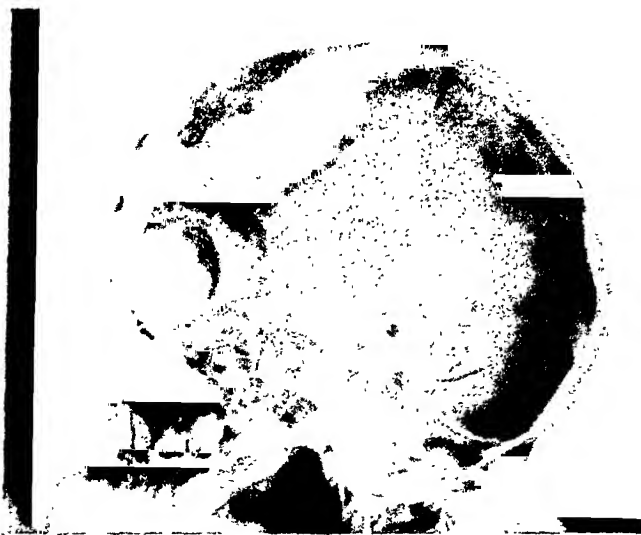


FIG. 23. Case VI. June 8, 1943. Note extension and large frontal flap.

noticed occasional right frontal headaches and slowly increasing polydipsia and polyuria.

On return to the hospital, June 8, 1943, roentgenograms of the skull showed extension of the cranial lesions (Fig. 23), and another course of roentgen therapy was given, with 1,900 r, measured in air, to 6 by 8 cm. fields, right, left, and anterior, over the involved regions of the skull, using the factors described above. Patient went home June 25, 1943, and returned August 11, 1943.

One week before return, she became nauseated and bled very extensively from her gums.

On readmission, significant physical findings were: (1) intense jaundice; (2) diffuse petechial hemorrhages and ecchymoses; (3) roentgen-ray discoloration over frontal regions; (4) left exophthalmos; (5) bleeding spongy gums; (6) blood pressure of 96/58.

Significant laboratory findings were: (1) anemia of 2,200,000; (2) white blood cell count of 2,200; (3) slight albuminuria; (4) urine sediment showed 8 red cells per high power field; (5) platelet count 26,160; (6) greatly increased bleeding, clotting, and prothrombin time.

Little except supportive therapy was given and the patient rapidly became worse and died on August 15, 1943.

Comment. The most striking diagnostic features of this patient were the convulsions and somnolence, due to the very extensive leptomeningeal spread over the frontal lobes, first interpreted as a post-partum psychosis. After radiation therapy and decompression, this patient's cranial symptoms were relieved for a year to the extent that she was able to lead a fairly normal life, though there was no change in her unusually extreme exophthalmos. The biopsy description of reticulo-endothelial hyperplasia, without foam cell formation, confused everyone connected with the case, though all were most impressed with the striking symptomatic improvement after radiation therapy. The terminal development of an acute hemorrhagic diathesis closely resembles the course of the recorded cases of Letterer-Siwe disease. The terminal jaundice suggested involvement of the liver as well as the hemopoietic system. Unfortunately, necropsy permission was not obtained.

CASE VII. E.S., female, Negro, aged fifty-three, married, was admitted to John Sealy Hospital, March 4, 1944, for a work-up as a patient with chronic cholecystitis. She gave a history of inflamed eyelids and sinus trouble for twenty years, and attacks resembling gallbladder colic for one year.

Significant physical findings were: (1) tenderness over gallbladder region; (2) chronic pansinusitis; (3) chronic conjunctivitis and blepharitis; (4) obesity; (5) blood pressure of 198/80; (6) limitation of motion of cervical and dorsal spine; (7) multiple papulosquamous nevi over the back, slightly darker than the skin, diagnosed by Dr. C. N. Frazier as xanthomata; (8) mild exophthalmos, bilateral.

Roentgen findings were: (1) normally functioning gallbladder; (2) advanced arteriosclerotic disease with expansile pulsation of the

aortic root; (3) marked osteoarthritis of the cervicodorsal spine; (4) a punched out lesion, 4 by 5 cm., in the left temporoparietal region (Fig. 24); (5) marked erosion about the roots of all the teeth.

Significant laboratory findings were: (1) electrocardiogram showed advanced myocardial damage; (2) anemia of 4,000,000; (3) differential count showed 4 per cent eosinophils; (4) blood cholesterol of 210.

In view of the multiplicity of complaints and



FIG. 24. Case VII. March 4, 1944. Large left temporoparietal defect.

the shortage of hospital beds, patient was discharged without treatment, and no follow-up has been obtained.

Comment. This patient, though inadequately studied, showed, in addition to cranial and mandibular defects, the only instance I have been able to find of cutaneous involvement of reticulo-endotheliosis in the Negro race. The sinusitis and conjunctivitis were her most outstanding complaints, once a normal gallbladder had been demonstrated.

DISCUSSION

The most important single feature in diagnosis of reticulo-endotheliosis is the appearance of the cranial bones on roentgen examination. The characteristic lesions show only bone destruction without evidence of any new bone formation, have sharp edges which may be irregular, and produce a larger defect in the inner than

the outer table. These findings are due to slowly increasing size of individual lesions, with destruction of adjacent bone by pressure. The lesions, when palpable, are soft, which readily distinguishes them from malignant metastases, but most commonly the scalp shows areas of depression at the site of the lesions. The lesions in other bones closely simulate the benign bone cyst.

Diagnosis is based on the presence, together with characteristic defects in the cranial bones, of malnutrition, chronic low grade anemia, disturbances in growth and development, diabetes insipidus, involvement of other bones, especially the mandible, and less frequently exophthalmos, jaundice, skin lesions, generalized lymphadenopathy, aural discharge, hemorrhagic diathesis and occasionally pituitary-gonad disturbances.

The histopathological picture is so variable that pathological confirmation of the diagnosis is the exception rather than the rule—a single specimen examined by a number of pathologists will frequently be given as many different diagnoses.

The important feature of management of reticulo-endotheliosis appears to be early recognition of the disease, through astute correlation of the bizarre findings with the characteristic appearance of the cranial roentgenograms. As soon as the diagnosis is made, radiation therapy to every organ or region which the signs indicate is involved is highly desirable. One of the author's patients (Case IV) has been carried for ten years in this manner.

The disease, except in the acute Letterer-Siwe type, shows a strong tendency toward spontaneous remission. Irradiation is given in the hope of supporting the patient and causing retrogression of individual lesions and improving the patient symptomatically till the appearance of a remission. Nutritional therapy, of a number of kinds, has not been shown to be of value, though we are awaiting the result of massive doses of vitamin A in our Case IV.

Radiation therapy may be given in

divided doses, to any involved area, using filtration sufficient to protect the superficial structures and insure adequate depth dosage. Deep roentgen therapy, in the 200 kv. range is entirely adequate for this purpose. Dosage to an individual lesion or region is much smaller than the cancerocidal dose would be, and adequate treatment can usually be given without permanent change in the skin or its appendages.

All of the cases, except one, which I have treated, showed very marked improvement after irradiation of the involved areas—the exception showed some improvement but no therapy was directed to the pancreas, site of the tumor causing her terminal symptoms. In each of the 4 children, therapy was apparently of definite supportive value until appearance of a spontaneous remission.

In infants and very young children, the form of reticulo-endotheliosis known as Letterer-Siwe disease is acute and rapidly fatal. Also, in adults, reticulo-endotheliosis seems to run a chronic to subacute course, with massive terminal involvement of an essential organ or system. However, the great majority of cases apparently develop in children beyond infancy and before puberty. In these, local radiation therapy of involved areas has been shown to be of great value and to improve the prognosis, both immediate and final, very markedly.

CONCLUSIONS

1. The literature on reticulo-endotheliosis is reviewed at length.
2. Evidence is presented that reticulo-endotheliosis may assume an acute, fatal, non-lipoid form, in infants and young children, known as Letterer-Siwe disease.
3. In older children and adults, the less acute disease is characterized by lipoid deposit and corresponds in every respect with what has been described as Hand-Schüller-Christian disease.
4. At any stage of its course, Hand-Schüller-Christian disease may assume a subacute fatal character.
5. Evidence is presented that so-called

eosinophilic granuloma is a variant form of reticulo-endotheliosis, with a usual solitary bone lesion, eosinophilia in the areas of reticulo-endothelial proliferation, and probable widespread soft tissue involvement.

6. The small amount of reported experimental work in reticulo-endotheliosis is described.

7. The bizarre and widely varied presenting signs of reticulo-endotheliosis are shown to be due to largely accidental location of areas of reticulo-endothelial proliferation.

8. Seven cases of reticulo-endotheliosis are presented, with histories and illustrations, and are discussed at length.

9. The importance of roentgenography of the skull in diagnosis is emphasized.

10. The role of radiation therapy in palliation of the patient until the appearance of a characteristic spontaneous remission in the non-acute type is emphasized.

23 E. Pikes Peak Ave.
Colorado Springs, Colo.

REFERENCES

1. ABT, A. F., and DENENHOLZ, E. J. Letterer-Siwe's disease. *Am. J. Dis. Child.*, 1936, 51, 499-522.
2. CHRISTIAN, H. A. Defects in membranous bones, exophthalmos and diabetes insipidus; an unusual syndrome of dyspituitarism. *Med. Clin. North America*, 1919, 3, 849.
3. GROSS, P., and JACOX, H. W. Eosinophilic granuloma and certain other reticulo-endothelial hyperplasias of bone. *Am. J. M. Sc.*, 1942, 203, 673-687.
4. HAND, ALFRED, JR. Polyuria and tuberculosis. *Arch. Pediat.*, 1893, 10, 673.
5. KENNEDY, R. L. J. Xanthomatosis: Schüller-Christian's disease. *Proc. Staff Meet., Mayo Clin.*, 1938, 13, 776-781.
6. LEWIS, W. H., and LEWIS, M. R. The transformation of white blood cells into clasmatoocytes (macrophages), epithelioid cells, and giant cells. *J.A.M.A.*, 1925, 84, 798-799.
7. MACCALLUM, W. G. A Textbook of Pathology. W. B. Saunders Co., Philadelphia.
8. MIYAJI, S. Experimentelle Beiträge zur Frage der xanthomatösen Erkrankungen. *Arch. f. klin. Chir.*, 1938, 192, 190-208.
9. ROWLAND, R. S. Xanthomatosis and the reticulo-endothelial system. *Arch. Int. Med.*, 1928, 42, 611-674.
10. ROWLAND, R. S. Christian's syndrome and lipoid cell hyperplasias of the reticulo-endothelial system. *Ann. Int. Med.*, 1929, 2, 1277-1299.
11. SCHÜLLER, A. Ueber eingenartige Schädeldefekte im Jugendalter. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1915-1916, 23, 12.
12. SIWE, S. A. Die Reticuloendotheliose—ein neues Krankheitsbild unter den Hepatosplenomegalien. *Ztschr. f. Kinderh.*, 1933, 55, 212-247.
13. SOSMAN, M. C. Xanthomatosis (Schüller's disease; Christian's syndrome). *Am. J. Roentgenol. & Rad. Therapy*, 1930, 23, 581-597.
14. SOSMAN, M. C. Xanthomatosis (Schüller-Christian's disease; lipoid histiocytosis). *J.A.M.A.*, 1932, 98, 110-117.
15. WALLGREN, A. Systemic reticuloendothelial granuloma. *Am. J. Dis. Child.*, 1940, 60, 471-500.



NODULAR PULMONARY DENSITIES DUE TO SCARS OF MULTIPLE PULMONARY INFARCTS*

By CHARLES E. GRAYSON, M.D.

SACRAMENTO, CALIFORNIA

THE roentgenographic appearance of pulmonary infarcts has recently been studied extensively by Hampton and Castleman.¹ Their studies, with pathologic anatomical correlation, show that pulmonary infarcts are rarely triangular in shape though their shadows may be roughly triangular. These authors state that the infarcts are always peripheral and sharp in outline.

One might suspect that a greater proportion of infarcts would present a triangular shadow, if the distal boundary thereof were limited to one plane of the visceral pleura. This would apply to smaller infarcts, which would have less chance of involving more than one surface, by geometric probability. It is also obvious that the direction of the central roentgen ray, in respect to the axis of symmetry, greatly influences the shadow outline.

Infarcts are usually seen singly or in small numbers. When multiple, they are often large and associated with fatal outcome. However, they are occasionally seen as multiple small lesions, nodular or even miliary in size. The case reported herein is an instance of this type.

CASE REPORT

A forty year old Negro porter entered the San Francisco City and County Hospital on February 19, 1946, and died eight days later. He had "chills and fever" for two weeks and had felt ill with headache and a dull mid-abdominal pain. His urine had become foul smelling, he had nocturia, frequency and urgency. Exertional dyspnea had been present for six years, a slightly productive cough for two years and orthopnea for ten days before entry.

A previous hospital entry had been made in 1943 for tonsillitis. A roentgenogram of the chest on November 26, 1943 (Fig. 1) disclosed small nodular densities throughout both lung

fields. The blood Wassermann reaction was positive and antiluetic therapy was given for one year. The blood pressure was 125/75. He had used "opium" intravenously for eighteen years, with chills frequently following injections.

At the last entry he appeared ill and dyspneic. He was shaking with chills. Temperature, 104.4° F.; pulse, 120 per minute; respiration, 38 per minute; blood pressure, 120/40.

The antecubital veins were scarred. Petechiae were noted in the right conjunctiva. The neck veins were distended and marked venous pulsations were visible with the patient in a sitting position. Moist rales were heard over the posterior position of the chest at the lung bases and wheezes throughout the chest. A violent cardiac apex impulse was felt in the sixth intercostal space 2 cm. lateral to the mid-clavicular line. There was an apical systolic thrill. The aortic second sound was absent. A loud to-and-fro murmur could be heard throughout the precordium. The spleen was palpable 3 cm. below the left costal margin. The liver was not palpable. Tenderness was present in the right costovertebral angle. The fingernails were slightly rounded and the feet puffy without pitting edema.

Blood: Hemoglobin 78 per cent (Sahli). Erythrocytes, 3,700,000; leukocytes, 11,800; neutrophil leukocytes, 82 per cent. Blood urea, 33 milligrams per cent. Serum proteins, 5.8 grams per cent (albumin 2.9 grams, globulin 2.9 grams). Blood Wassermann reaction, positive. The blood cultures showed gram-negative rods of the coli-aerogenes group. Urine: (twenty-four hour period) amount 900 cc.; specific gravity, 1.015; pH, 5.0; granular casts, 200,000; erythrocytes, 48,000,000; leukocytes, 72,000,000. Protein or sugar was not found.

Lumbar puncture gave no positive findings. Chest roentgenogram on February 19, 1946, showed "a small triangular density at the right costophrenic angle" plus the small nodular densities noted three years before (Fig. 2, 3).

He was given sulfadiazine for the bacteriemia and digitalis for cardiac decompensation. How-

* From Stanford University School of Medicine, Department of Radiology at San Francisco Hospital, J. C. Geiger, M.D., Director of Public Health; L. H. Garland, M.D., Visiting Radiologist in charge of service.

ever, dyspnea, leg edema and the number of petechiae increased. Irrationality and coma progressed and he died eight days after entering the hospital.

Postmortem examination revealed aortic valve vegetations with rupture of the posterior cusp. The liver and spleen were large. Numerous septic infarcts were present in the spleen and kidneys. These were of recent origin. In addition, there were quite numerous small (2 to 5 mm.) firm nodules throughout both lungs. Histopathologic studies, using elastic tissue stains and the usual hematoxylin-eosin stains, showed these nodules to have characteristics of old infarcts without evidence of inflammatory

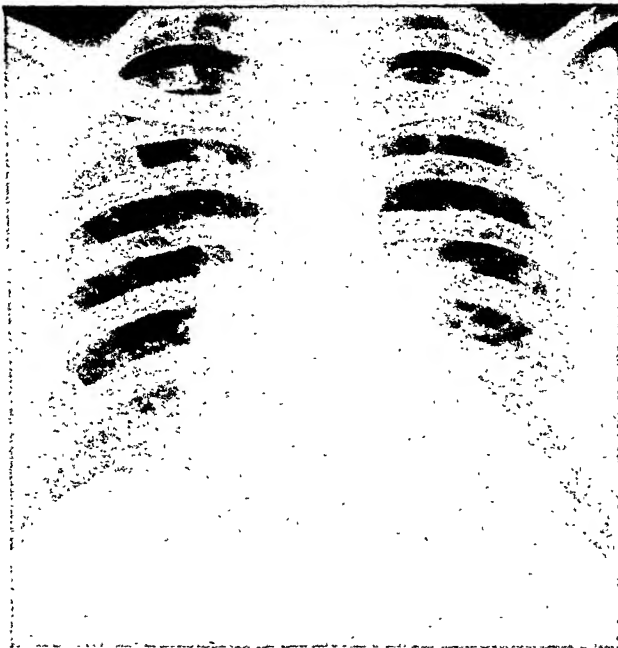


FIG. 1. Fine densities throughout both lung fields in 1943.

reaction. The following is a description of one of these by Dr. David A. Wood:

6D-52 F: "One section of lung shows a small oval non-encapsulated nodule which consists of collapsed pulmonary tissue in which all vestiges of alveolar walls are absent. Present in the condensed fibrous tissue are occasional small capillaries lined with swollen endothelium and containing blood. There is no inflammatory reaction in this nodule. Elastic tissue stains show the usual amount of elastic tissue fibers. Otherwise the pulmonary tissue shows moderate deposition of anthracotic pigment in the septa and some of the alveolar walls. Most of the alveoli in the adjacent parenchyma are air-containing. Some alveoli contain desquamated cells and

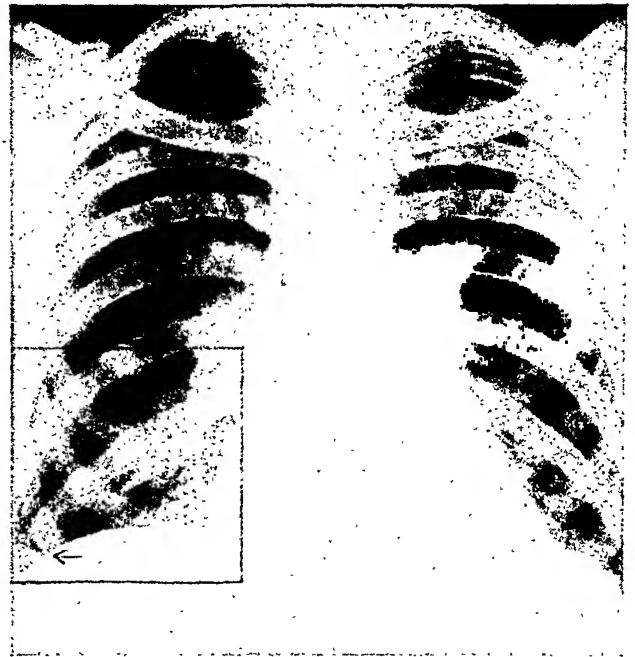


FIG. 2. Appearance of lungs in 1946 similar to 1943.

slightly thickened alveolar walls. A few of the latter are infiltrated with lymphocytes."

COMMENT

The three year persistence of the scattered pulmonary nodules and the eventual appearance of one triangular density in the final fulminating episode of bacteriemia



FIG. 3. Right lower lung field in 1946. Note the triangular clouding and profuse fine nodular densities.

might have assisted in the identification of the pulmonary process. The triangular shape of the largest pulmonary infarct corresponded to the usual didactic description. However, the true significance of the multiple nodular densities was not recognized.

Whether these old infarcts were secondary to bacterial emboli or injected particulate matter incidental to his addiction is still undetermined. The lack of evidence of inflammatory reaction or scarring is of interest to note. Obviously the recent infarcts were associated with the endocarditis and bacteriemia. That intravenous use of opiates by addicts is not infrequently followed by bacteriemia and multiple septic emboli has been reported.² In this instance, there may well have been some insoluble residuum of crude or poorly refined opium obtained in more recent years.

It is recognized that there is, unfortunately, no diagnostic feature which would permit recognition of this unusual condition in the roentgenogram. The term "in-

farctosis" was applied to this unusual roentgenographic appearance by L. H. Garland following his review of the case. This seems a most descriptive and apt designation.

SUMMARY

A case of multiple pulmonary infarcts, simulating disseminated or miliary pulmonary disease, is presented. This occurred in an addict using opiates administered intravenously for eighteen years.

1181 Cavanaugh Way
Sacramento, Calif.

REFERENCES

1. HAMPTON, A. O., and CASTLEMAN, B. Correlation of postmortem chest teleroentgenograms with autopsy findings, with special reference to pulmonary embolism and infarction. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 305-326.
2. HUSSEY, H. H., KELIHER, T. F., SCHAEFER, B. F., and WALSH, B. J. Septicemia and bacterial endocarditis resulting from heroin addiction. *J.A.M.A.*, 1944, 126, 535-538.



THE CLINICAL AND ROENTGEN MANIFESTATIONS OF PNEUMONIA DUE TO *BACILLUS MUCOSUS CAPSULATUS* (PRIMARY FRIEDLÄNDER PNEUMONIA)*

By MAX RITVO, M.D., and FRANCIS MARTIN, M.D.

BOSTON, MASSACHUSETTS

INTRODUCTION

FRIEDLÄNDER pneumonia is a relatively infrequent yet very important type of pneumonia. It is a severe disease in which the mortality is markedly elevated,^{3,32} approximately 70 to 80 per cent of cases terminating fatally. In the patients who do not succumb, there is a high incidence of complications, many developing chronic lung abscesses which run a very prolonged course. The use of sulfonamides^{20,30} and penicillin^{10,36} has not influenced the mortality in Friedländer pneumonia to an appreciable extent. However, the early administration of streptomycin^{16,24,27} has resulted in recovery in some instances with a definite diminution in the death rate. As the ordinary types of pneumonia have been greatly reduced in frequency and mortality by modern methods of therapy, the more virulent and resistant Friedländer pneumonia has become of increasing importance. Early recognition of the disease and the immediate institution of therapy are of the utmost importance. The roentgenologist's ability to indicate the diagnosis or to confirm the suspicions of the clinician may prove of the greatest value. As with other rare and unusual conditions, the diagnosis will be made only after the demonstration of findings characteristic of the disease and if the possibility of the condition is borne in mind.

ETIOLOGY

Friedländer pneumonia is more common in males in the ratio of 5:1. The majority of cases occur between forty and sixty-five years of age, only a few instances having been recorded in children.^{12,21,25} A history

of alcoholism is often present and is probably a predisposing factor. Malnutrition and other debilitating influences are also significant. Cold and exposure are important, there being a definitely higher incidence in the winter months. There is frequently a history of long-standing, persistent cough or previous respiratory tract infection with bronchitis and bronchiectasis. It has been noted by many authors that a source of infection of the Friedländer bacillus is present in the accessory nasal sinuses, the throat, or upper air passages. In one of our patients, elimination of the organism from the sputum was not accomplished until the focus in the sinuses had been eliminated. In this type of case, there is not infrequently a history of previous attacks of Friedländer pneumonia.

BACTERIOLOGY AND EPIDEMIOLOGY

Friedländer's bacillus was first described in 1882 by Carl Friedländer¹⁴ who considered it the causative organism in most cases of pneumonia. With the subsequent demonstration that the pneumococcus was the etiologic agent in lobar pneumonia,³⁴ the pendulum swung to the belief that Friedländer's bacillus was never the cause of pneumonia, being merely a secondary invader. It is now generally accepted that a small but definite percentage, variously estimated at from 0.5 to 5 per cent,³² of all pneumonias are of the primary Friedländer type. Friedländer's bacillus, commonly referred to as *Bacillus mucosus capsulatus*, is a short, gram-negative, non-motile, nonspore-forming rod with a thick capsule.³⁹ Julianelle,²² in 1926 and 1930, identified two main types: A and B. Types

* From the Department of Radiology, Boston City Hospital, Boston, Mass.

C, D, E and a mixed group X are also described. The soluble specific substance of the capsule of Friedländer's bacillus Type B and of pneumococcus Type II are closely related and the sera of one will protect mice against infection with the other. Type specific antisera have been found useful in therapy. Friedländer's bacillus was demonstrated in the upper respiratory tract of 2.2 per cent of a large group of healthy individuals tested by Bullowa, Chess and Friedman.⁶ The organism may be present in the blood stream and distant metastatic foci occur in the meninges, vertebrae, and so forth. In apparently healthy individuals Friedländer's bacillus has been isolated from the stools, urine, bile, vagina, and uterus. In addition it has been found in soil, air, dust, mud, and water.² The incubation period is not definitely known but appears short, being estimated at about forty-eight hours.^{12,32} Epidemics are rare although they have been reported.³⁸ The role carriers play in this disease has not been determined.⁵ Baehr *et al.*² believe that primary pulmonary Friedländer infection is rare and that most cases begin as liver, biliary tract, and urinary infections, the lung being a secondary seat of invasion, oftentimes as a terminal event. Study of the literature, however, indicates that definite primary infection does occur. It will be remembered that the pneumococcus, streptococcus and other pathogens similarly may appear as saprophytes, secondary invaders, or in association with extrapulmonary invaders, and Friedländer's bacillus undoubtedly is similar to the pneumococcus in this respect also.

PATHOLOGY

Any lobe or combination of lobes may be involved. Usually more than one lobe is affected.^{20,28} The consolidation is oftentimes described as being lobular or "confluent lobular,"²³ rather than lobar. Solomon³² reports lobar type of involvement in 84 per cent and lobular in 16 per cent. He noted involvement of more than one lobe in 65 per cent of his cases. There is apparently

no predilection for any particular lobe. The affected lobe or lobes are usually bright red to chocolate-brown in color and less frequently pink or grayish. The involved portion of the lung is voluminous. There is considerable inflammatory reaction in the pleura with a reddish, fibrinous pleural exudate. The cut surface of the lung is covered with viscid, abundant, mucinous exudate which characteristically is very tenacious. The alveolar exudate is usually brick-red, glairy, mucoid, or gelatinous. Friedländer's bacillus is well known as a destroyer of parenchymal lung tissue.^{17,19,28} Abscesses filled with pus are of common occurrence.^{33,35} Destruction of the alveolar walls is often found microscopically although it may not be demonstrable grossly. Pulmonary edema, pleural effusion, empyema, pericarditis, and meningitis are complications found at autopsy in a high percentage of cases. Portal cirrhosis and fatty liver are probably not infrequent.²⁰ Jaundice is present in over 10 per cent of acute cases.³²

CLINICAL COURSE

The onset is sudden, usually starting with cough, sputum, hemoptysis, pleuritis, pain, and a chill.²⁰ Cyanosis and dyspnea may be present. In many instances, the patient appears desperately ill from the onset of the disease. The temperature varies from 99° to 106° F., although most observers note that temperatures below 102° F. are common.³² The pulse and respiratory rate correspond to the elevation of temperature. The leukocyte count may aid in suggesting the diagnosis as in many cases there is only a relatively slight leukocytosis.²⁸ Solomon³² found no marked increase in the white count in 63 per cent of his cases, and in only 12 per cent did it exceed 20,000. Leukopenia and monocytosis may occur. The physical signs are not diagnostic. The sputum may be brick-red and homogeneous as though blood and mucus had been mixed together to form an emulsion. This appearance is found in only a small percentage of cases, the majority showing sputum similar to that found in

lobar pneumonia. Bacteremia is common but is usually not marked and there is no direct relationship between the mortality rate and the degree of bacteremia.³² The usual course of acute Friedländer pneumonia is to early death, usually in two to six days, and this has been the end result in from 51 to 97 per cent^{3,20,32} of previously reported cases. The average mortality rate is 70 to 80 per cent. Some patients recover rapidly and completely. The third possibility is the development of a chronic form of Friedländer pneumonia with necrosis and the formation of one or more thin-walled lung abscesses.^{7,17,22,26} There is a definite tendency for tuberculosis to develop after Friedländer pneumonia.²⁰

DIFFERENTIAL DIAGNOSIS

Acute Friedländer pneumonia must be differentiated from pneumonia caused by the pneumococcus, hemolytic streptococcus, staphylococcus, influenza bacillus and the viruses.¹³ The individual with Friedländer pneumonia is usually over forty, males predominating greatly. Frequently there is a history of a chronic respiratory infection preceding the onset of the acute Friedländer pneumonia.^{13,28} The patient while obviously gravely ill may have a temperature which does not rise above 102° F. Herpes, which is so commonly seen in lobar pneumonia, is not frequent. The sputum is usually thick, glairy, mucoid, and oftentimes brick-red. In many cases, the physical signs are not commensurate with the degree of lung involvement as found by roentgen examination or at postmortem. In pneumococcus pneumonia, the temperature is usually high and the physical signs of lobar consolidation are characteristic. The respirations are short and grunting and the sputum is rust colored. A well marked leukocytosis, predominantly polymorphonuclear cells, is present. Hemolytic streptococcus pneumonia often follows streptococcal infection elsewhere in the body. Pharyngitis, laryngitis, and tracheobronchitis commonly precede the pneumonia. The consolidation is of the diffuse.

patchy type. The sputum is blood streaked or bloody. Staphylococcus pneumonias are usually seen in early childhood. In adults this type of pneumonia is metastatic from other foci or follows influenza. The temperature is high and the consolidation is patchy. The sputum is purulent and is usually mixed with varying amounts of blood. Influenzal pneumonia is most common in infancy and early childhood. In adults it occurs in pandemics as in 1918. It may develop in adults after long-standing chronic bronchopulmonary infections. The virus types of pneumonia are more common in young adults. The onset tends to be gradual with headache and a chilly sensation but rarely a true chill. Presternal soreness occurs frequently. True consolidation is uncommon. A peribronchial infiltration, usually spreading from the hila, is seen at roentgen examination. Weakness and persistent cough are frequent but severe prostration and death are rare. The chronic form of Friedländer pulmonary infection, usually with thin-walled cavities and abscesses, must be differentiated from the large group of diseases characterized by patchy or peribronchial infiltrations.^{8,17,23} Pulmonary tuberculosis is usually the first consideration.^{7,33,27} Some cases of Friedländer pneumonia, because of the roentgen demonstration of areas of marked, uniform density, may be diagnosed as neoplasm of the lung with fluid, atelectasis, or both. The history of acute onset, marked toxicity, leukopenia, and comparatively low temperature, coupled with the inability to obtain fluid on chest tap, are important factors in arriving at a correct diagnosis.

ROENTGEN FINDINGS

There is no single roentgen picture which occurs regularly in Friedländer pneumonia. Based on a review of the literature and the 14 cases which we have observed, the following roentgenologic classification of this disease is suggested:

Group 1. The Massive Lobar Consolidation Type. The affected portion of the lung is markedly and uniformly dense, apparently

due to very large quantities of exudate. At times, a single lobe is involved. In others, massive consolidation of the entire lung field occurs. These patients may be seen early in the course of the disease and at that time, the dense, lobar type of consolidation is fully established, apparently having been present almost from the onset. In some instances, the affected lobe(s) seem to bulge, fluid (the so-called "drowned lung") being suspected. The impression of fluid is further strengthened when the entire lung field is involved with displacement of the heart and trachea to the opposite side. The density obliterates the outlines of the ribs, the heart border and, when the base is involved, the shadow of the diaphragm and costophrenic angle. The roentgen changes are in practically every instance interpreted as being due to neoplasm and fluid and the chest is tapped without fluid being obtained. Massive atelectasis may be suspected, although the absence of ipsilateral displacement of the heart and mediastinal contents militates against this diagnosis. The cases which present the massive lobar consolidation are practically always rapidly fatal, death resulting from an overwhelming toxicity and in some instances occurring within twelve to twenty-four hours from the onset.

Group 2. The Lobular Consolidation Type. In the early stages, there is a patchy, irregular density which later develops into a confluent consolidation scattered through one or more lobes. This group is larger than the massive lobar variety and is usually indistinguishable roentgenographically from other lobular pneumonias. This type has a very high mortality rate also, although many recover with resolution or continue as the chronic form of Friedländer pneumonia to be described below.

Group 3. The Chronic Form Characterized by Lung Abscess Formation and Pulmonary Suppuration. As mentioned above, lung abscesses may form relatively early in the course of Friedländer pneumonia. They are apparently due to the thick, viscid, tenacious exudate which produces obstruction with subsequent atelectasis and ischemia.

Delayed resolution is also a common occurrence with chronic suppuration and abscess formations of varying size which persist for very long periods. These changes closely resemble pulmonary tuberculosis or bronchiectasis both clinically and roentgenologically. They may undergo partial or complete clearing only to recur despite therapy. In some instances, the destruction of pulmonary tissue is so extensive that it is referred to as spontaneous lobectomy.

It is in the massive lobar consolidation (Group 1) that the roentgenologist may be of the greatest aid to the clinician. Massive consolidation involving one or more lobes should immediately suggest the possibility of Friedländer pneumonia. Since death may occur within a matter of hours or days, early roentgen diagnosis is of the utmost importance. Streptomycin appears effective in some instances, while penicillin and the sulfonamides are of doubtful value. Prompt institution of therapy may prove a life saving procedure. The diagnosis of chronic Friedländer pneumonia must be considered when the roentgenogram demonstrates diffuse, mottled, peribronchial infiltrations with cavitations, particularly in cases in which the tubercle bacillus cannot be isolated. Although Friedländer's bacillus may be only one of several organisms found the use of streptomycin, particularly by the aerosol method, may produce beneficial results.

REVIEW OF THE LITERATURE

Friedländer¹⁴ first described the *Bacillus mucosus capsulatus* in 1882 and erroneously concluded that this organism was the etiologic agent in the majority of cases of lobar pneumonia. Etienne¹¹ in 1895 recorded early observations as to the prevalence of the Friedländer's bacillus in the respiratory tract of normal individuals and noted the patchy nature of the pulmonary lesion in type of pneumonia. Apelt¹ in 1908 reported a series of cases and stressed the high mortality as well as the tendency to the development of lung abscesses. Sisson and Thompson³¹ listed 33 cases of primary Friedländer pneumonia in their

review of the literature prior to 1915 and added 4 additional cases. Zander³⁵ (1919) reported an epidemic of 411 cases in a labor camp in Germany. This is the largest number of cases recorded by any author and the only epidemic. However, a critical analysis by Solomon³² casts doubt upon the authenticity of these cases as being definitely proved Friedländer pneumonia. Julianelle²² in 1916 classified Friedländer's bacillus into three main types: A, B, and C, and a heterogenous group X by means of agglutination, absorption, and precipitin reactions and by passive protection tests. Belk³ reported 18 cases, all fatal. Westmark³⁷ (1926) observed the tendency of Friedländer pulmonary infection to simulate tuberculosis. Kornblum²³ in 1928 and a year later with Collins⁸ described the roentgen appearances of Friedländer pneumonia in both the acute and chronic forms. He pointed out the close similarity of the chronic forms to pulmonary tuberculosis and gave a roentgenologic classification of the stages of primary Friedländer pneumonia. Olcott²⁸ found that in 4 of 6 cases the consolidation at postmortem was lobar in character. He noted the occurrence of leukopenia and the high percentage of large mononuclear cells. Solomon³² (1937 and 1940) reviewed both the primary and chronic forms of Friedländer pulmonary infection and included 32 cases of the primary type and 17 of the chronic variety. The acute cases were predominantly lobar (84 per cent), the remainder being bronchopneumonic in type. He indicated the frequency of multilobar involvement, the characteristic sputum, the leukopenia, and the high mortality rate. Solomon stated that the chronic form of Friedländer infection usually followed the acute disease and emphasized the frequency of upper lobe involvement with cavitation, findings which usually resulted in an incorrect diagnosis of pulmonary tuberculosis. Bullowa, Chess and Friedman⁶ in 1937 recorded 41 cases of acute pneumonia due to the Friedländer bacillus. They quoted French authors who classified the various types as follows: (1) the hyperacute characterized by overwhelm-

ing toxicity, massive consolidation and practically always a fatal termination; (2) the acute type with hepatization, abscess formation, and occasional recovery; and (3) the subacute or suppurative pneumonic type in which the patient survives the first stage to experience an extended period of remission and exacerbation, ultimately developing clinical and roentgenographic evidence of cavitation. Bullowa observed that the consolidation was frequently lobar but noted the frequency of extension beyond the interlobar fissure with multilobar involvement. Perlman and Bullowa³⁰ in 1941 recorded 37 cases and stressed the inadequacy of therapy. Hyde and Hyde²⁰ in 1943 reported 51 cases. They found the incidence of Friedländer pneumonia to be 1.6 per cent of the pneumonias at Bellevue Hospital. All lobes showed approximately equal frequency of involvement. Positive blood cultures were present in 45 per cent of cases. The role of streptomycin and streptomycin with penicillin, which may be an effective form of therapy for Friedländer pneumonia, has been reviewed by Finland *et al.*^{16,29}, Bishop and Rasmussen,⁴ Learner and Minnich²⁴, Welford,³⁶ Geier,¹⁵ Nichols and Herrell²⁷, the Committee on Therapeutics,⁹ Heilman,¹⁸ and others.

CASE REPORTS

CASE 1. The massive lobar consolidation type (Group 1). E. P., white male, aged sixty-three, was admitted October 17, 1946, with a history of pain in the left chest for the past week. The patient was acutely ill with labored breathing and moderate respiratory distress. The history could not be obtained from the patient and the family was vague in the description of the illness. There was a history of chronic cough and weight loss prior to the present illness. Temperature 100° F., pulse 118, respirations 35, blood pressure 140/70. On physical examination there was dullness over the left anterior chest and axilla with diminished breath sounds. Breath sounds were faintly audible at the left base posteriorly. The right lung was clear. Laboratory data: White blood cell count 16,400 (81 per cent polymorphonuclear cells); red blood cell count 3.5 million (60 per cent Hgb); nonprotein nitrogen 50 mg. The sputum was negative for



FIG. 1. Case 1. The massive lobar consolidation type of Friedländer pneumonia.

(A) Anteroposterior view one day after admission to the hospital. There is uniform density involving practically the entire left lung field except small areas at the apex and the axillary portion of the base. The density obliterates the outlines of the left ribs and cardiac border. The heart and trachea are displaced to the right. The left diaphragm is faintly visualized and is elevated.

(B) Lateral projection. The density involves the entire left upper lung field and the anterior portion of the middle and lower lung field, indicating involvement of the left upper lobe. The posterior portions of the left middle and lower lung fields show slight mottling, due to patchy consolidation of the left lower lobe. The left upper lobe is increased in size and bulges. The changes are those of massive consolidation of the left upper lobe, the uniform density being due to the great amounts of exudate. The affected lobe is large and bulges. The displacement of the heart and trachea to the opposite side produces a picture which closely simulates pleural effusion or tumor. At postmortem examination, the massive density of the left upper lobe was found to be caused by the thick, viscid exudate. (Courtesy of John F. Sheehan, M.D., St. Vincent's Hospital, Worcester, Mass.)

tubercle bacilli. The blood culture showed *Streptococcus viridans*.

Course. The patient's condition became steadily worse with increasing dyspnea. Treatment consisted of penicillin and oxygen. Repeated attempts were made to aspirate fluid from the left chest without success. The pulse remained approximately 100 and the respirations 30-40. His temperature never rose above 101° F. He died on October 23, six days following admission.

Postmortem. The left pleural cavity is obliterated by old and recent fibrinous adhesions. The heart and mediastinum are displaced slightly to the right. The left upper lobe is markedly increased in size, bulging in all directions. It is dark purple in color and completely solidified. On section it shows a reddish gray, finely gran-

ular appearing surface and there is a large quantity of thick pus exuding from it. The exudate was very viscid and gram stain showed large numbers of organisms morphologically typical of Friedländer's bacillus. The lower lobe also showed areas of consolidation, but this was much less marked than in the upper lobe. (This case is presented through the courtesy of Dr. John F. Sheehan, St. Vincent's Hospital, Worcester, Mass.)

CASE II. The massive lobar consolidation type (Group 1). J. A., colored male, aged sixty-two, was admitted to the hospital March 14, 1946, in a very toxic condition. He stated he had been ill for four or five days with cough, left chest pain, severe chills, high fever, dyspnea, and profuse sweating. There was no history of

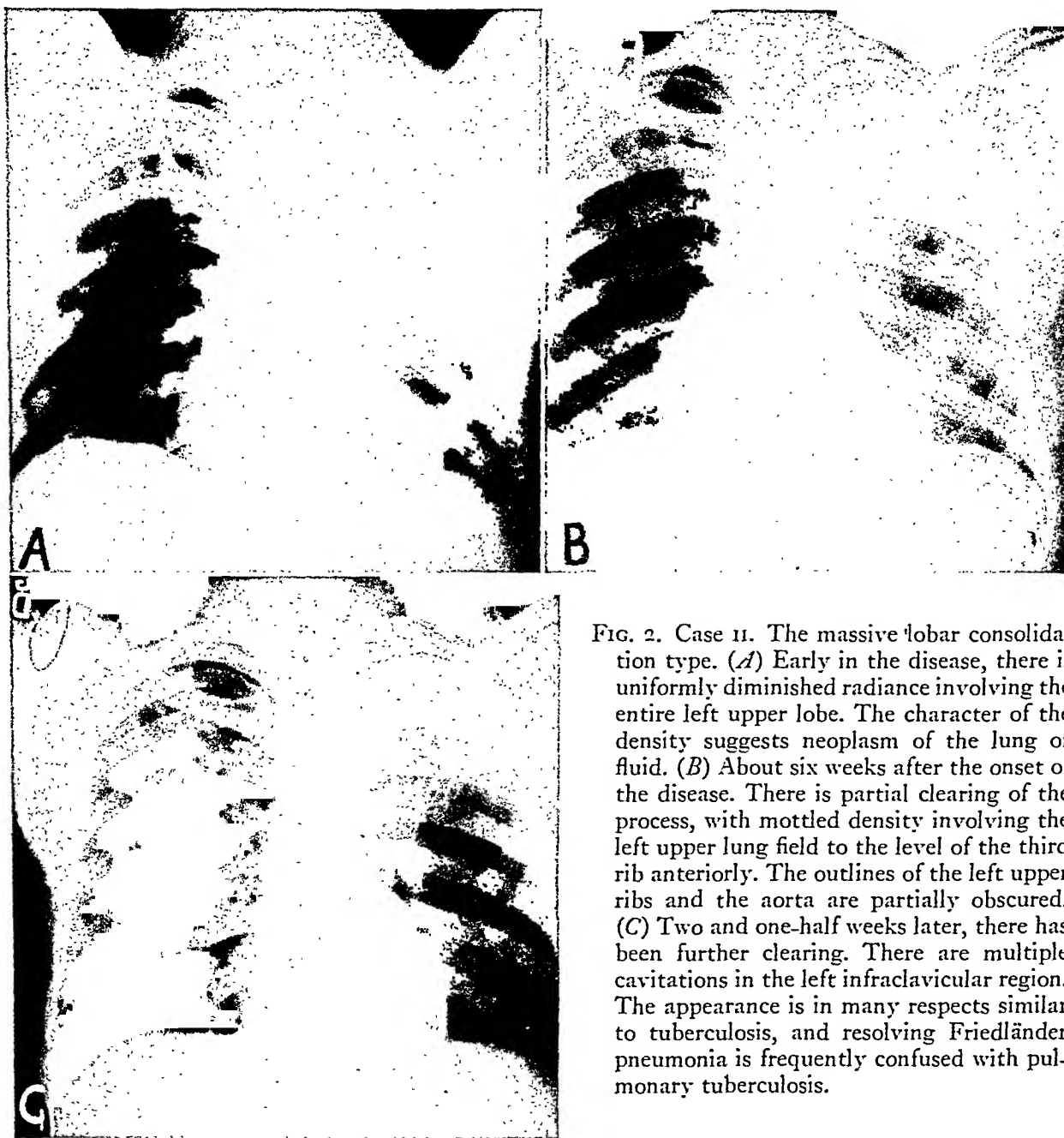


FIG. 2. Case 11. The massive lobar consolidation type. (A) Early in the disease, there is uniformly diminished radiance involving the entire left upper lobe. The character of the density suggests neoplasm of the lung or fluid. (B) About six weeks after the onset of the disease. There is partial clearing of the process, with mottled density involving the left upper lung field to the level of the third rib anteriorly. The outlines of the left upper ribs and the aorta are partially obscured. (C) Two and one-half weeks later, there has been further clearing. There are multiple cavitations in the left infraclavicular region. The appearance is in many respects similar to tuberculosis, and resolving Friedländer pneumonia is frequently confused with pulmonary tuberculosis.

tuberculosis. He was obviously very acutely ill and disoriented. Temperature 103°F ., pulse 116, respirations 50.

Laboratory data: White blood cell count 12,400 (polymorphonuclears 68 per cent) on admission. Two days later the white blood cell count was 12,000. The sputum culture showed *Bacillus mucosus capsulatus* Group A and when repeated on April 9 and May 5 the same organism was present. Blood cultures developed no growth.

Course. The patient was given oxygen, penicillin, and sulfadiazine. After a stormy course during forty-eight hours he improved rapidly, the temperature dropping to 98.6°F . within

four days. Roentgen studies did not demonstrate corresponding clearing of the pulmonary condition, however. Fluid with cavitation in the left upper lobe developed subsequently. Tuberculosis was suspected but all tests to demonstrate the organism were unsuccessful and guinea pig inoculation was negative. After being ambulatory and asymptomatic for a month the patient was discharged from the hospital although the roentgenogram had not cleared completely. He has been observed in the Out-Patient Department and has continued well.

CASE III. The lobular consolidation type (Group 2). J. S., male, aged forty-four, laborer,



FIG. 3. Case III. Friedländer pneumonia, lobular type. Roentgenogram on the day of admission to the hospital reveals irregular, mottled density throughout the entire left lung field and in the axillary portion of the right upper and mid-lung field. There is a rounded area of radiance measuring about 4 cm. in diameter in the left lung field slightly below the angle of the scapula (arrow) in the region of the seventh and eighth interspaces, consistent with a cavitation.

admitted December 7, 1944, with a history of not having felt well for the past three weeks. Tiredness, cough with yellow sputum, and occasional chills were the first complaints. Subsequently he developed a sore throat, pain in the chest on deep inspiration, coughing, general malaise, and increasing dyspnea. There was a long history of chronic alcoholism. On physical examination, he was described as "poorly nourished, dyspneic, with foul odor to breath." Decreased expansion, dullness, coarse and fine, moist rales were present throughout the left lung. The breath sounds and vocal fremitus were decreased. There was a friction rub in the anterior axillary line in the fifth and sixth interspaces.

Laboratory data: Blood pressure 110/60, temperature 102° F., pulse 110, respirations 42. Urine, negative. Red blood cell count 3.54 million, leukocyte count 22,300 (normal differential count). Sputum culture revealed *Bacillus mucosus capsulatus* on two occasions. The blood

culture showed no growth. Roentgen examination of the chest demonstrated lobular pneumonia involving the left upper lobe, the left lower lobe, and the right upper lobe with an abscess formation in the left inferior lung field.

Course. The patient appeared very ill on admission. He was placed on sulfadiazine, oxygen, and supportive measures. The white blood cell count, which on admission was 22,300, decreased to 8,500 on the sixth hospital day. The temperature remained elevated and dyspnea was a constant feature. He grew progressively worse and died on the ninth day.

CASE IV. The chronic form characterized by abscess formation and chronic suppuration (Group 3). M. C., male, aged fifty, entered the hospital on November 7, 1946, because of sudden onset of severe left chest pain and a chill. Cough, nausea, and vomiting occurred several times before admission. There was a history of three previous admissions with recurrent Friedländer pneumonia. On physical examination, there was splinting of the left side of the chest with decreased breath sounds and dullness over the left lower chest. A friction rub and coarse dry rales and rhonchi were present.

Laboratory data: White blood cell count 15,600 (79 per cent polymorphonuclears, 2 per cent monocytes). Sputum cultures showed *Bacillus mucosus capsulatus* Type A and were negative for the tubercle bacillus. Roentgen examination demonstrated mottled density at the left base and linear strands of fibrosis overlying the right diaphragm.

Course. During his stay in the hospital a left maxillary sinusitis and ethmoiditis was found. *Bacillus mucosus capsulatus* was isolated from cultures of the left antrum. The temperature on admission was 99° F. and rarely rose above normal. Although the patient improved clinically the organism persisted in the discharge from the sinuses and in the sputum. Streptomycin was administered with the aerosol apparatus for ten days. Cultures taken from the nose and throat became negative for Friedländer's bacillus after the second day of treatment and remained so until he was discharged well on January 21, 1946.

CASE V. The chronic form characterized by abscess formation and suppuration (Group 3). J. W., male, white, aged fifty-nine, was admitted September 21, 1946, with a history of a

"cold for the past week." Two days previously he had developed severe pleuritic pain in the right anterior chest and a cough productive of purulent sputum. On admission, he appeared acutely ill and in a shock-like state. The skin was flushed, tongue dry, lips and finger nails cyanotic. Temperature 98.6° F., pulse 120, respirations 32, blood pressure 95/55. There were signs of consolidation over the lower half of the right chest anteriorly and a few medium crepi-

culture on admission was positive for Type C Friedländer's bacillus.

Course. Streptomycin was administered intramuscularly 1 gram every four hours for two days and then at six hour intervals for four days. The patient's general condition began to improve within a few hours. He became stronger and his appetite returned. The pleuritic pain diminished and the dyspnea lessened. Subsequent blood cultures were negative.

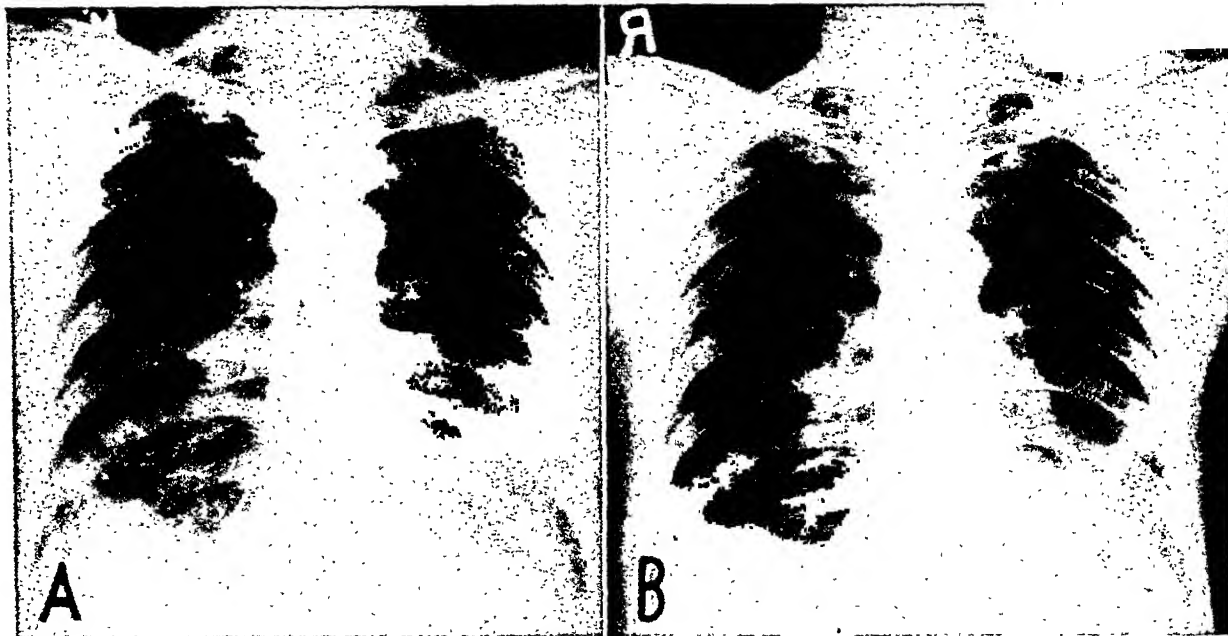


FIG. 4. Case IV. The chronic type with abscess formation and suppuration. (A) Thirteen days after onset. There is a diffuse, irregular mottling involving the lower third of the left lung field and the right base. There are multiple small cavitations on the left. (B) About six weeks later. The process is less marked, indicating moderate clearing. There are small cavities at the left base. The right diaphragm is elevated and irregular and the costophrenic angle is shallow and hazy.

tant rales throughout the left chest posteriorly. The heart was not enlarged and no murmurs were heard; the rhythm was irregular.

Laboratory data: Hemoglobin 110 per cent, leukocyte count 25,000 (96 per cent polymorphonuclears with 50 per cent young forms). The sputum was tenacious, purulent, and bloody. A stained smear showed innumerable, large, encapsulated, gram-negative bacilli and a few gram-positive diplococci. A Neufeld test with antipneumococcus serums showed "quellung" of some of the diplococci with Type 19 antiserums. Cultures of the sputum on blood agar yielded only Friedländer's bacilli and this organism and Type 7 pneumococci were obtained from cultures of the heart's blood of a mouse inoculated with the sputum. The blood

Friedländer's bacilli persisted in the sputum in varying numbers. Type 7 pneumococci were isolated on one occasion and Type 19 were found several times. On the fifth day, signs of cavitation of the right middle lobe were elicited clinically and confirmed by the roentgenogram. Streptomycin was discontinued intramuscularly and subsequently was given by inhalation of 125 mg. dissolved in 1 ml. of saline ten times daily. Each inhalation was preceded by a five minute period of postural drainage. The patient improved and the number of Friedländer's bacilli in the sputum decreased. On the tenth day, because of the persistence of large numbers of Type 19 pneumococci in the sputum and elevation of the temperature, the patient was again given intramuscular penicillin, 100,000

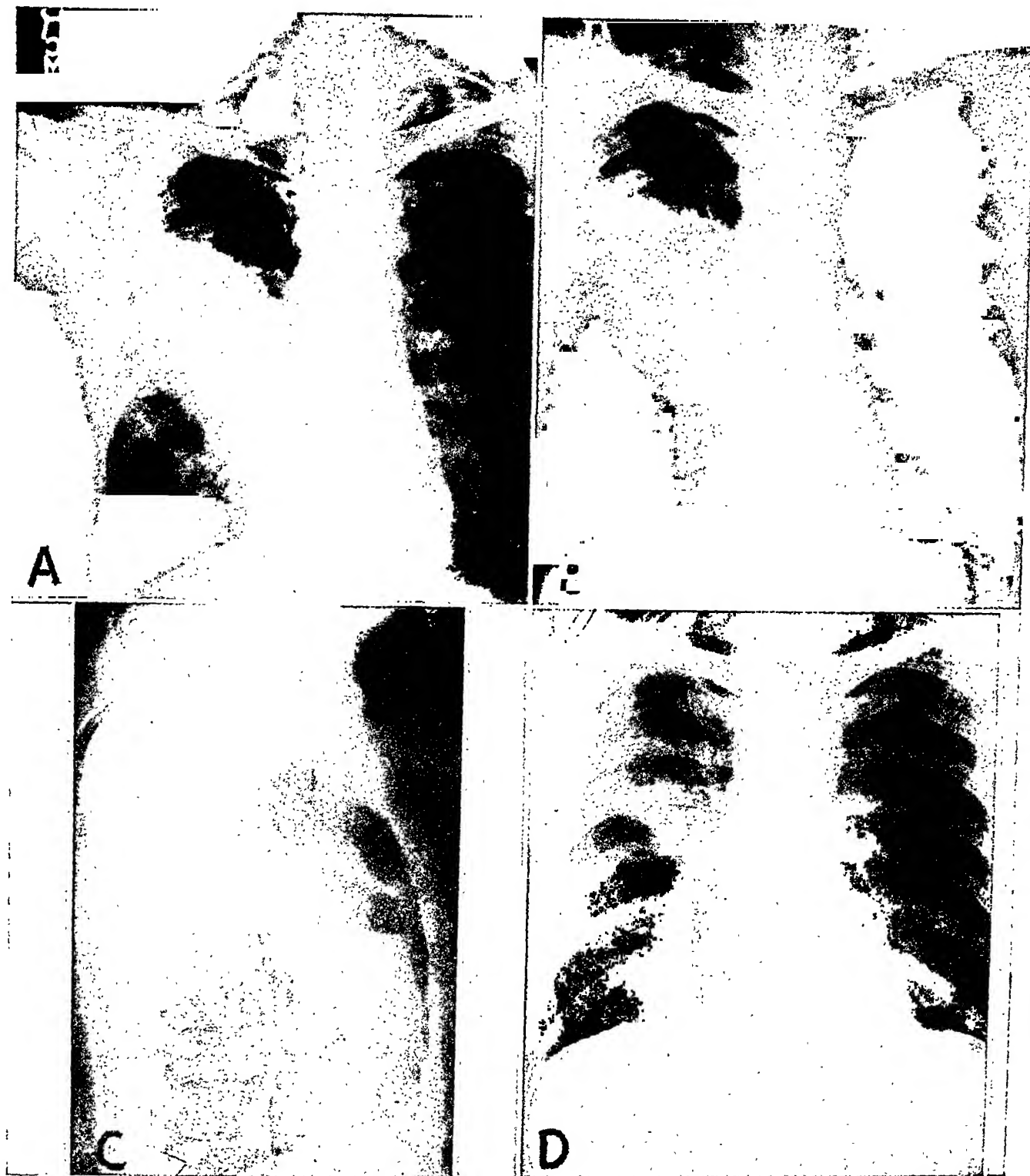


FIG. 5. Case v. The chronic type with abscess formation. (A) Two days after onset. There is an area of marked density in the right mid-lung field. The margins of the affected area are sharply defined. The left lung is unaffected. (B) Eleven days later. There is a large cavitation within the involved area. (C) Same day as in (B), lateral projection, patient standing. The fluid level in the cavity is clearly demonstrable. (D) Seven weeks after the onset of the illness. The process has cleared markedly and there is now a narrow band of density adjacent to the right hilum.

units every eight hours. The temperature dropped promptly and the number of pneumococci in the sputum diminished. Both penicillin and streptomycin were discontinued on the seventeenth day. At this time the patient had only a slight residual cough, raised moder-

ate amounts of purulent sputum, and had some sweating at night. The roentgenograms still showed an area of consolidation with several small abscesses. During the following two months the patient remained afebrile and symptom free and regained much weight and

strength. The area of pulmonary consolidation diminished in size and showed evidences of fibrosis. The abscesses became smaller and finally disappeared completely. Friedländer's bacillus continued to be the predominant organism in the sputum cultures, Type 19 pneumococci not being found after the third week.

SUMMARY AND CONCLUSIONS

Friedländer pneumonia is relatively infrequent. Nevertheless it is a very important type of pneumonia because of its severity, the high incidence of complications, and the markedly elevated mortality rate. Early recognition of the disease and the prompt institution of therapy are of the utmost importance. The clinical manifestations are described.

The roentgen findings are variable. There is a massive lobar consolidation variety, a lobular form, and a type characterized by chronicity with lung abscess formation and pulmonary suppuration. It is in the massive lobar consolidation variety of the disease that the roentgenologist may be of the greatest aid to the clinician, although the roentgen studies are also of value in the demonstration of the other types of Friedländer pneumonia.

Streptomycin appears beneficial in some cases of Friedländer pneumonia especially if commenced early in the acute phase. Penicillin and the sulfonamides do not appear to have influenced the mortality in this disease to any appreciable extent.

416 Marlboro St.
Boston 15, Mass.

REFERENCES

1. APELT, F. Ueber die durch den Bacillus Pneumoniae Friedländer hervorgerufene Pneumoniae. München. med. Wchnschr., 1908, 55, 833.
2. BAEHR, G., SHWARTZMAN, G., and GREENSPAN, E. B. (1) The rôle of Bacillus friedländer in infections. *Tr. A. Am. Physicians*, 1933, 48, 353-354. (2) Bacillus Friedländer infections. *Ann. Int. Med.*, 1937, 10, 1788-1801.
3. BELK, W. P. Pulmonary infections by Friedländer's bacillus. *J. Infect. Dis.*, 1926, 38, 115-126.
4. BISHOP, C. A., and RASMUSSEN, R. F. Klebsiella pneumonia treated with streptomycin. *J.A.M.A.*, 1946, 131, 821-822.
5. BLOOMFIELD, A. L. The mechanism of the bacillus carrier, with special reference to the Friedländer bacillus. *Am. Rev. Tuberc.*, 1921, 4, 847.
6. BULLOWA, J. G. M., CHESSE, J., and FRIEDMAN, N. B. Pneumonia due to Bacillus friedländeri. *Arch. Int. Med.*, 1937, 60, 735-752.
7. COLLINS, L. H., JR. Chronic pulmonary infection due to the Friedländer bacillus. *Arch. Int. Med.*, 1936, 58, 235-249.
8. COLLINS, L. H., JR., and KORNBLUM, K. Chronic pulmonary infection due to Friedländer bacillus; clinical and roentgenologic study. *Arch. Int. Med.*, 1929, 43, 351-362.
9. Committee on Chemotherapeutics and Other Agents, National Research Council. Streptomycin in treatment of infections; report of one thousand cases. *J.A.M.A.*, 1946, 132, 4-11; 70-76.
10. Editorial. *New England J. Med.*, 1946, 233, 449.
11. ETIENNE, G. Le pneumobacille de Friedländer; son rôle en pathologie. *Arch. de med. exper.*, 1895, 7, 124.
12. FERGUSON, J. A., and TOWER, A. A. Pneumonia in infants due to Bacillus mucosus-capsulatus. *Am. J. Dis. Child.*, 1933, 46, 59-68.
13. FINLAND, M. Pneumonia. *Am. J. Med.*, 1946, 1, 507-517.
14. FRIEDLANDER, C. Ueber die Schizomyceten bei der acuten fibrösen Pneumonie. *Virchow's Arch. f. path. Anat.*, 1882, 87, 319.
15. GEIER, F. M. A case of Friedländer's bacillus pneumonia treated with streptomycin. *Permanent Found. M. Bull.*, 1946, 4, 159-163.
16. HARRIS, H. W., MURRAY, R., PAINE, T. F., and FINLAND, M. Streptomycin treatment of pulmonary infections. *New England J. Med.*, 1947, 236, 611-622.
17. HART, A. L. The postpneumonic lung; critical review. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 26, 371-396.
18. HEILMAN, F. R. Streptomycin in treatment of experimental infections with micro-organisms of Friedländer group (Klebsiella). *Proc. Staff. Meet., Mayo Clin.*, 1945, 20, 33-39.
19. HUMPHREYS, D. R. Spontaneous lobectomy. *Brit. M. J.*, 1945, 2, 185-186.
20. HYDE, L., and HYDE, B. Primary Friedländer pneumonia. *Am. J. M. Sc.*, 1943, 205, 660-675.
21. JAMPOLIS, M., HOWELL, K. M., CALVIN, J. K., and LEVENTHAL, M. L. Bacillus mucosus infection of the new-born. *Am. J. Dis. Child.*, 1932, 43, 70-88.
22. JULIANELLE, L. A. Biological classification of Encapsulatus pneumoniae (Friedländer's bacillus). *J. Exper. Med.*, 1926, 44, 113-128. Immunological relationships of encapsulated and capsule-free strains of Encapsulatus pneumoniae (Friedländer's bacillus). *J. Exper. Med.*, 1926, 44, 683-696.

- Immunological relationships of cell constituents of *Encapsulatus pneumoniae* (Friedländer's bacillus). *J. Exper. Med.*, 1926, 44, 735-751.
Distribution of Friedländer's bacilli of different types. *J. Exper. Med.*, 1930, 52, 539-545.
23. KORNBLUM, K. The roentgen-ray diagnosis of pulmonary infections with the Friedländer bacillus. *Am. J. Roentgenol. & Rad. Therapy*, 1928, 19, 513-521.
 24. LEARNER, N., and MINNICH, W. R. Friedländer pneumonia treated with streptomycin; report of a case with prompt recovery. *Ann. Int. Med.*, 1946, 25, 516-520.
 25. MILLER, B. W., ORRIS, H. W., and TAUS, H. H. Friedländer's pneumonia in infancy. *J. Pediat.*, 1947, 31, 521-527.
 26. MUSCHENHEIM, C. Chronic Friedländer's infection of the lung. *Internat. Clin.*, 1940, 3, 216-224.
 27. NICHOLS, D. R., and HERRELL, W. E. Streptomycin; its clinical uses and limitations. *J.A.M.A.*, 1946, 132, 200-206.
 28. OLCOTT, C. T. Pneumonia due to Friedländer's bacillus. *Arch. Path.*, 1933, 16, 471-479.
 29. PAINE, T. F., MURRAY, R., and FINLAND, M. Medical progress; streptomycin; clinical uses. *New England J. Med.*, 1947, 236, 748-760.
 30. PERLMAN, E., and BULLOWA, J. G. M. Primary Bacillus Friedländer (*Klebsiella pneumoniae*) pneumonia. *Arch. Int. Med.*, 1941, 67, 907-920.
 31. SISSON, W. R., and THOMPSON, C. B. Friedländer bacillus pneumonia, with report of cases. *Am. J. M. Sc.*, 1915, 150, 713-727.
 32. SOLOMON, S. (1) Primary Friedländer pneumonia. *J.A.M.A.*, 1937, 108, 937-947. (2) Chronic Friedländer infections of the lungs. *J.A.M.A.*, 1940, 115, 1527-1536.
 33. SWEANY, H. C., STADNICHENKO, A., and HENRICHSEN, K. J. Multiple pulmonary abscesses simulating tuberculosis caused by Friedländer bacillus. *Arch. Int. Med.*, 1931, 47, 565-582.
 34. STERNBERG, Y. M. The Pneumonia-coccus of Friedländer. *Am. J. M. Sc.*, 1885, 90, 106; 435.
 35. TAYLOR, J. W. Spontaneous lobectomy. *Brit. M. J.*, 1944, 2, 500-501.
 36. WELFORD, N. T. Recovery from primary Friedländer pneumonia (type B) on therapy with sulfadiazine and penicillin. *Illinois M. J.*, 1946, 90, 185-187.
 37. WESTERMARK, N. Ein Tuberculose vortauschender Fall von Friedländers Pneumonie mit lange sich hinziehendem Verlauf. *Acta radiol.*, 1926, 7, 626-631.
 38. ZANDER, A. Ausgedehnte Endemie von Lungenentzündungen durch Infektion mit Friedländerschen Pneumobazillen unter Zivilarbeiten. *Deutsche med. Wchnschr.*, 1919, 45, 1180.
 39. ZINSSER, H., and BAYNE-JONES, S. A Text Book of Bacteriology. D. Appleton-Century Co., New York, 1940.



A CASE OF ANEURYSM OF THE DUCTUS ARTERIOSUS WITH POSTMORTEM ROENTGENOLOGIC STUDY AFTER INSTILLATION OF BARIUM PASTE

By JOHN H. KNEIDEL, M.D.

INDIANAPOLIS, INDIANA

WHEREAS simple patency of the ductus arteriosus is second only to patent foramen ovale as the most common congenital lesion of the heart, aneurysm of the ductus arteriosus is indeed rare. Mackler and Graham¹³ reviewed the literature in 1943 and concluded that only 30 cases of true ductus aneurysm had been reported, including the one reported by them at that time. Because of the rarity of the condition, and because of its interest to the roentgenologist and the thoracic surgeon as one type of mediastinal tumor, the author reports the following case of aneurysm of the ductus arteriosus found at the postmortem examination of a three weeks old infant.

HISTORICAL

The first cases of aneurysm of the ductus arteriosus were described by French authors with Billard¹ in 1837, Martin St. Ange and M. Parise,¹⁶ Geoffrey St. Hilaire and Baron¹⁷ reporting a total of 4 cases. Thore²⁰ in 1850 reviewed the cases previously reported by the French and added 8 of his own. Other reports of aneurysm of the ductus arteriosus which are now generally regarded as being cases of true ductus aneurysms include one reported by Hebb¹⁰ in 1893, three cases described by Roeder¹⁵ in 1901, two by Esser³ in 1902, one case by Grunner⁷ in 1904, and a case reported by Thorel²¹ in 1904. Subsequent cases were reported by Weller²² in 1915, Frolicher⁴ in 1917, one by Schattman¹⁸ in 1919, and one case reported by Dry² in 1921. Hammer-schlag⁹ reviewed the literature and added a case of his own in 1925. Guggenheim⁸ in 1930 and Scheef¹⁹ in 1939 each reported cases of true aneurysm of the ductus arteriosus. Graham⁵ reported 2 cases of ductus aneurysm in 1940. Mackler and Graham¹³ reported another case in 1943 and

reviewed the literature thoroughly at that time.

ETIOLOGY OF ANEURYSM OF THE DUCTUS ARTERIOSUS

The etiology of aneurysm of the ductus arteriosus is not clear. Langer, Walkhoff and Thoma,¹² Kautsch and Klotz¹¹ as cited by Dry,² all pointed out that the ductus arteriosus is normally deficient in elastic tissue but is relatively rich in smooth muscle fibers. Dry concluded from his own case of aneurysm of the ductus arteriosus that the probable cause was a deficient development in both the elastic and the muscular elements of the ductus arteriosus. In Dry's case practically no elastic tissue and no intimal lining layer were found in the microscopic study of the specimen. Gross⁶ assumed that a thin or a structurally deficient wall of the ductus arteriosus was the main predisposing factor in its aneurysmal dilatation. Esser³ was able to demonstrate dissecting hemorrhages in the media of the ductus in his 2 cases. Frolicher⁴ also found hemorrhages in the media in his case. Mackler and Graham¹³ reviewed the literature and concluded that infectious processes could only be ascribed to be the etiologic factors in 3 of the 30 reported aneurysms. These authors advanced the theory that the basis for aneurysm of the ductus arteriosus lay in the inherent characteristics of that structure itself. They believe that the normal lack of elastic tissue associated with the abundance of smooth muscle is the natural predisposing factor to dilatation of a patent ductus arteriosus, when the latter is subjected to the high pressure of the blood within the aorta.

Ductus aneurysms are rarely found in adults. Of the 30 reported cases only 6 were present in adults, with the average age being thirty-one years. All others were

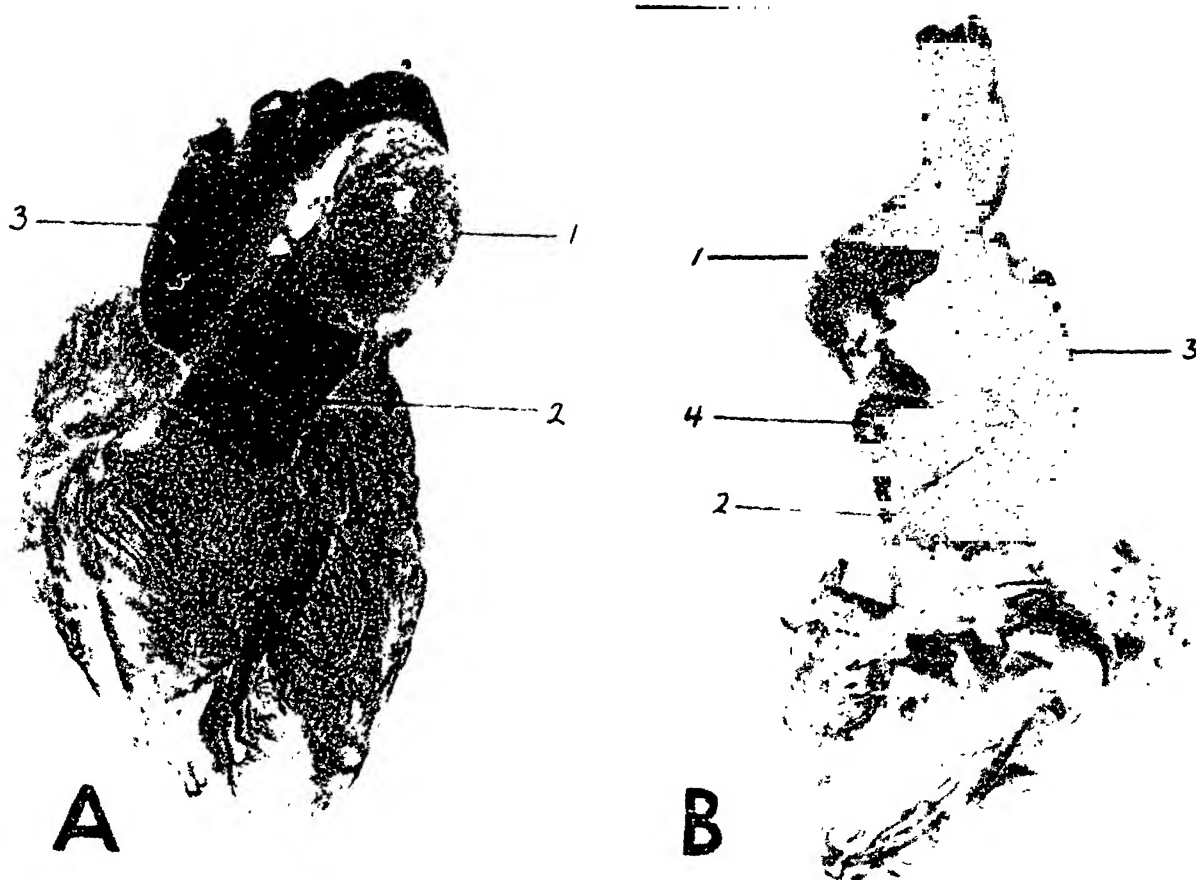


FIG. 1. Anterior view (A) and posterior view (B). (1) aneurysm of the ductus arteriosus, (2) pulmonary artery, (3) aorta, and (4) the left pulmonary artery. These views show the ductus aneurysm to extend anteriorly and to the left as an elliptical rounded structure. The pulmonary ostium of the aneurysm is proximal to the bifurcation of the pulmonary artery. Observe the dark color of the aneurysm as compared to the whitish appearance of the aorta and the pulmonary artery. This darker color is probably due to the lack of fibrous elastic tissue and the abundance of smooth muscle in the aneurysm. (These photographs are approximately 2X the actual size of the specimen.)

found during the postmortem examination of infants ranging from a few days to two months of age.

CASE REPORT

The patient was a premature female Negro infant of eight months gestation, born on October 8, 1947, and brought to the Indianapolis General Hospital because of prematurity. Birth weight was 3 pounds and 12 ounces. There were no unusual physical findings other than the prematurity of the infant.

The course in the hospital was uneventful for the first three weeks. However, at 6:00 p.m. on October 29 the infant's condition suddenly took a turn for the worse. For no apparent reason the infant passed into a shock-like state. The eyes, arms, and legs were noted to twitch repeatedly and appeared spastic. Breathing was of the gasping type, and even oxygen failed to relieve the dyspnea. The skin became

cold and clammy to the touch. The temperature fell to 96° F. Death occurred the following morning at 3:00 A.M.

Autopsy Report. The body was that of a premature Negro female infant measuring 40 cm. over-all length. The face and the upper portion of the body appeared cyanotic. No distinguishing external features were seen other than those of a general debility and poorly nourished state.

The interesting features of the case were found in the thoracic and cranial cavities. Examination of the thoracic cavity revealed a tumor of firm consistency located between the pulmonary artery and the aorta in the region normally occupied by the ductus arteriosus. This tumor measured 18 mm. in length and 14 mm. in width. It was cylindrical in shape but bulged anteriorly. Further examination and palpation revealed the tumor to be filled with clotted blood. With probing it was then obvious

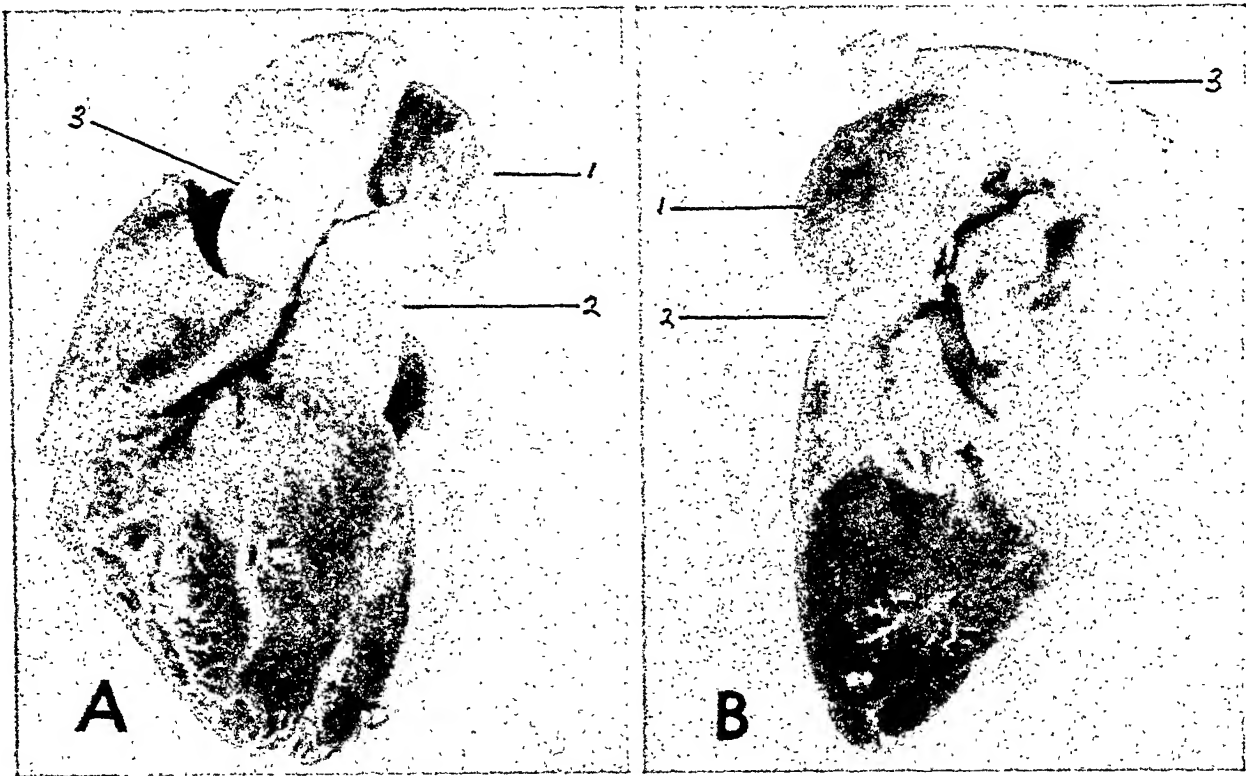


FIG. 2. Right anterior oblique view (A) and left lateral view (B). (1) ductus aneurysm, (2) pulmonary artery, and (3) aorta. The aneurysm of the ductus is seen to extend downwards, anteriorly and to the left in these views. (These photographs are approximately 2.5 X the size of the specimen.)

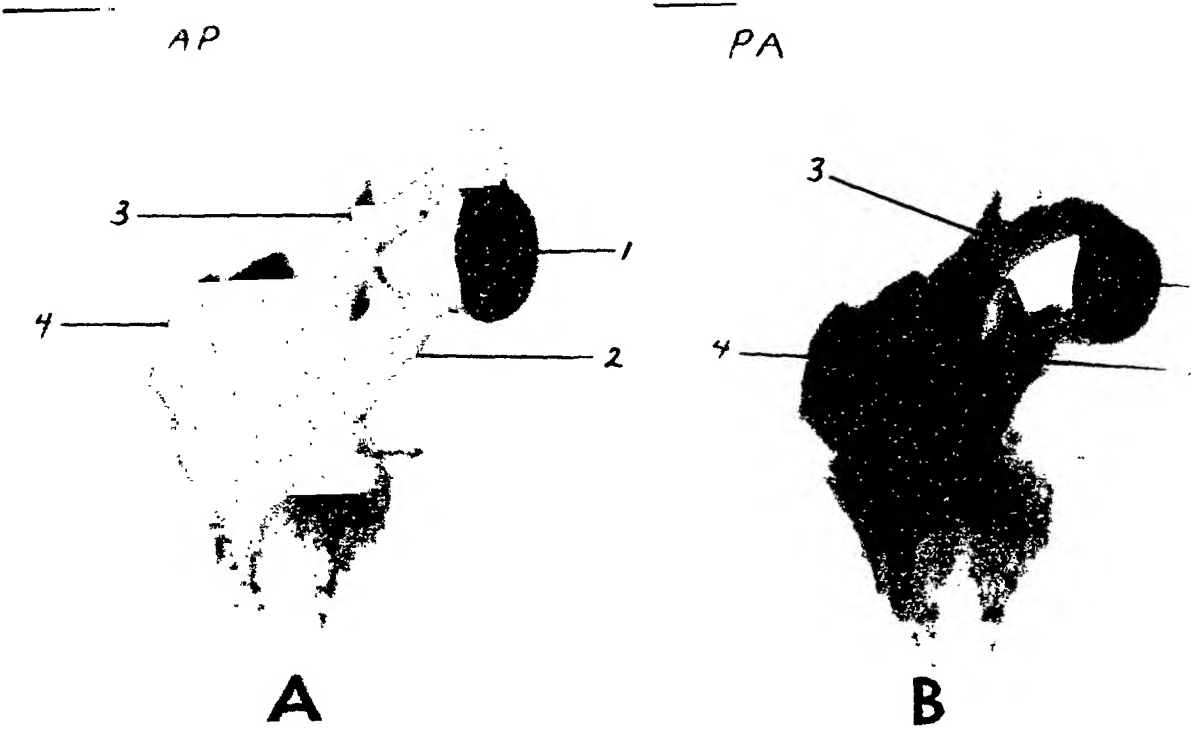


FIG. 3. Roentgenograms following the injection of barium paste. Anteroposterior view (A) and postero-anterior view (B). (1) ductus aneurysm, (2) pulmonary artery, (3) aorta, and (4) right ventricle. The aortic and pulmonary ostia are visualized at the upper and lower aspects of the aneurysm respectively. The aneurysm presents itself as a rounded elliptical shadow well to the left of the cardiac silhouette, and roughly located in a position between the aortic arch and the pulmonary conus.

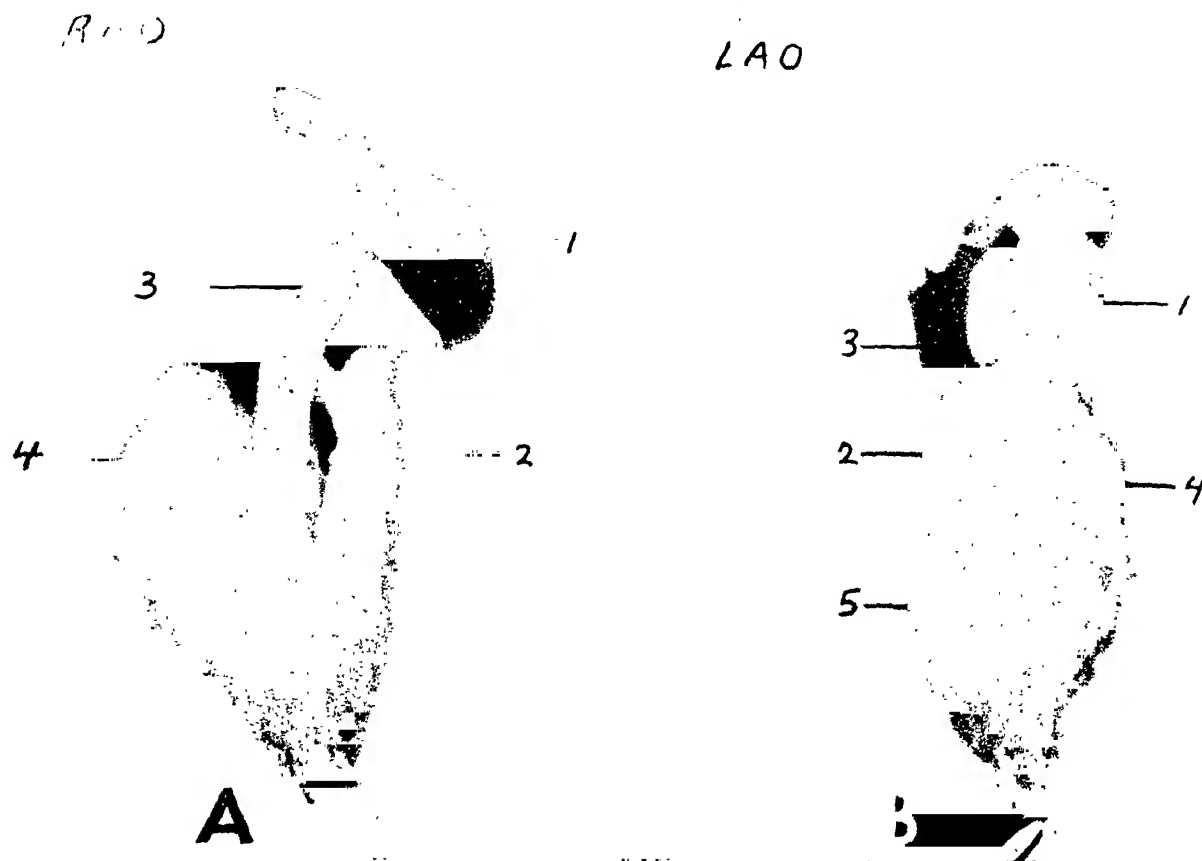


FIG. 4. Right anterior oblique view (A) and left anterior oblique view (B). (1) ductus aneurysm, (2) pulmonary artery, (3) aorta, (4) right auricle, and (5) right ventricle. In the right anterior oblique view the ductus aneurysm forms a rounded shadow above and to the left of the pulmonary conus. The aneurysm lies between the bulge produced by the conus and that of the aortic arch. In the left anterior oblique view the ductus aneurysm is seen to be posterior to the ascending limb of the aorta and within the area bounded anteriorly by the ascending aorta, superiorly by the aortic arch and posteriorly by the descending aorta. The so-called "aortic window," normally seen in this view, is essentially obliterated by an aneurysm of the ductus arteriosus.

that the tumor was an aneurysm of the ductus arteriosus.

On opening this ductus aneurysm, the wall was seen to be very thin and friable and one portion was discolored and appeared necrotic. From the gross examination the aneurysm appeared to be near rupture. The ostium at the aortic end measured 4 mm. in width and the pulmonary opening measured 2 mm. Microscopic study of the wall of the aneurysm revealed little if any elastic tissue but a large amount of smooth muscle.

Examination of the brain revealed a softening of the cerebral region normally supplied by the right internal carotid artery. This was believed to be due to a cerebral infarction secondary to an embolus which had its origin in the ductus aneurysm and which had lodged in the right internal carotid artery. Through an oversight the right internal carotid artery was not completely examined. Microscopic study revealed a typical early infarction of the right cerebral hemisphere.

Microscopic study of the lungs, liver, spleen, and the kidneys revealed a generalized congestion.

Pathologic Diagnosis: (1) aneurysm of the ductus arteriosus; (2) right cerebral infarction, secondary to (1); (3) congestion of the viscera.

DISCUSSION

The main value of this paper is in the accompanying illustrations of the pathologic specimen and the reproductions of the roentgenograms which were taken after the heart had been injected with a thick barium paste. Unfortunately no roentgenograms during life were taken, but it is only reasonable to assume that the features of the ductus aneurysm described with the illustrations would be the same or very similar to those produced during life. There is no doubt that the ductus would fill with contrast media such as diodrast during life,

using the method of Robb and Steinberg.¹⁴ Such filling would occur from the aorta because of the higher pressure within that vessel as compared to that within the pulmonary artery. The findings during life should be essentially the same as those shown in the accompanying illustrations of roentgenograms.

There are only 4 cases reported in which roentgen studies of ductus aneurysms were made during life, i.e., Scheef's case, Graham's 2 cases, and the case of Mackler and Graham in which the correct preoperative diagnosis was made from the roentgen study. Scheef had a chest roentgenogram (posteroanterior view) which showed the ductus aneurysm to produce a smooth rounded shadow of increased density in the left hilar region. Mackler and Graham pointed out that the most important feature in the roentgen diagnosis of ductus aneurysm was the peculiar location of the tumor. In all 3 of their cases they found the aneurysm to show as a tumor in the superior mediastinum, in the region of the pulmonary conus and lying posterior to the trachea. In 1 of their cases the periphery of the aneurysm showed as a distinct shell of calcification. In all 3 cases the trachea was displaced anteriorly and to the right by the tumor. Evidence of pulsation was sought for in all 3 of their cases and was found to be of the expansile type in only one. Graham explains this discrepancy on the basis of a laminated clot within the aneurysm and stresses the point that absence of pulsation should not keep one from making the diagnosis of ductus aneurysm if the other points are in favor.

From the case reported here it is obvious that the aneurysm has not enlarged or extended posteriorly, but instead has gone anterior to the trachea and the left bronchus. This is the only feature of the present case which is not in accordance with the diagnostic criteria laid down by Mackler and Graham in whose cases the aneurysm was always posterior to the trachea, displacing that structure anteriorly and to the right. Possibly this anterior extension of the ductus aneurysm in the present case was

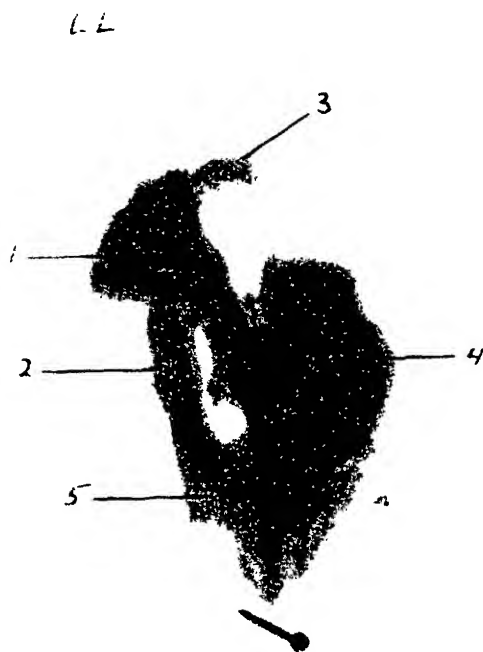


FIG. 5. Left lateral view. (1) ductus aneurysm, (2) pulmonary artery, (3) aorta, (4) right auricle, and (5) right ventricle. In the lateral view the ductus aneurysm is seen to extend anteriorly, producing a prominent bulge anterior to both the pulmonary conus and the aorta and again located roughly between these two landmarks. Such an aneurysm would present itself as a tumor of the anterior mediastinum and in the lower portion of the superior mediastinum. This tumor would then be anterior to the trachea and the left main stem bronchus.

due to the origin of the ductus arteriosus from the pulmonary artery proper rather than from the left pulmonary artery. At any rate it cannot be considered as a hard and fast rule that all aneurysms of the ductus arteriosus lie posterior to the trachea for they may be anterior to it as in the case reported here.

SUMMARY

(1) Aneurysm of the ductus arteriosus is a rare condition with thirty-one cases now reported. However, it is of importance to the roentgenologist and the thoracic surgeon as one type of mediastinal tumor. The attempted removal of such a tumor could result in uncontrollable hemorrhage and it would be well for a thoracic surgeon to be aware of the potentialities of such a complication.

(2) The peculiar location of such a tumor is its most significant feature:

- (a) In posteroanterior and anteroposterior views the aneurysm of the ductus arteriosus extends to the left and slightly above the pulmonary conus.
 - (b) In the right anterior oblique view the aneurysm is projected as a tumor mass to the left and superior to the pulmonary conus and between the latter and the aortic arch.
 - (c) In the left anterior oblique view the clear shadow of the "aortic window" is obliterated by the tumor produced by the ductus aneurysm.
 - (d) The lateral view in the present case shows the aneurysm to be anterior to the trachea and to extend farther anteriorly than either the pulmonary conus or the aorta. This is the only feature of the present case not in accordance with the diagnostic criteria laid down by Mackler and Graham who found that the aneurysm was posterior to the trachea in their three cases.
 - (e) The ductus aneurysm would produce a tumor shadow in the anterior mediastinum and in the lower portion of the superior mediastinum.
- (3) Visualization of the aneurysm with diodrast using the technique of Robb and Steinberg should establish the diagnosis.

I wish to acknowledge the help I received from the Departments of Pathology and Radiology at the Indianapolis General Hospital and especially the kind assistance of Dr. W. B. Dublin.

310 Berkeley Road
Indianapolis 8, Indiana

REFERENCES

1. BILLARD, C. M. Cited from Scheef.¹⁹
2. DRY, D. M. Congenital aneurysmal dilatation of the ductus Botalli. *Am. J. Dis. Child.*, 1921, 22, 181.
3. ESSER, J. Rupture of the ductus Botalli. *Arch. f. Kinderh.*, 1902, 33, 398.
4. FROLICHER, Cited from Scheef.¹⁹
5. GRAHAM, E. A. Aneurysm of the ductus arteriosus, with consideration of its importance to the thoracic surgeon; report of 2 cases. *Arch. Surg.*, 1940, 41, 324-333.
6. GROSS, R. E. Surgical management of patent ductus arteriosus, with summary of 4 surgically treated cases. *Ann. Surg.*, 1939, 110, 321-356.
7. GRUNER. Cited from Hammerschlag.⁹
8. GUGGENHEIM, A. Aneurysma des Ductus arteriosus Botalli mit Ruptur. *Frankfurt. Ztschr. f. Path.*, 1930, 40, 436-443.
9. HAMMERSCHLAG, E. True aneurysm of the ductus arteriosus. *Virchows Arch. f. path. Anat.*, 1925, 258, 1-8.
10. HEBB, R. G. Aneurysm of the ductus arteriosus and atheroma of the pulmonary artery. *Tr. Path. Soc. London*, 1893, 44, 45.
11. KAUTSCH and KLOTZ. Cited from Dry.²
12. LANGER, WALKHOFF and THOMA. Cited from Dry.²
13. MACKLER, S., and GRAHAM, E. A. Aneurysm of the ductus Botalli as a surgical problem, with review of the literature and report of an additional case diagnosed before operation. *J. Thoracic Surg.*, 1943, 12, 719-727.
14. ROBB, G. P., and STEINBERG, I. Visualization of the chambers of the heart, the pulmonary circulation, and the great blood vessels in man. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 1-17.
15. ROEDER, H. Thrombosis and aneurysmal dilatation of the ductus Botalli. *Virchows Arch. f. path. Anat.*, 1901, 166, 513.
16. ST. ANGE, M. M. Cited from Scheef.¹⁹
17. ST. HILAIRE, G. Cited from Hammerschlag.⁹
18. BARON. Cited from Hammerschlag.⁹
18. SCHATTMAN. Cited from Hammerschlag.⁹
19. SCHEEF, S. Rupture of mycotic aneurysm of the ductus Botalli and roentgen demonstration of enlarged duct in infant. *Arch. f. Kinderh.*, 1939, 117, 234-243.
20. THORE. Cited from Hammerschlag.⁹
21. THOREL. Cited from Scheef.¹⁹
22. WELLER, C. V. Congenital aneurysmal dilatation of ductus arteriosus. *Internat. A. M. Museums Bull.*, 1915, 5, 121.

COCCIDIOIDAL GRANULOMA OF BONE

By DAVID MILLER, M.D. and J. W. BIRSNER, M.D.

From the Department of Radiology, Kern General Hospital

BAKERSFIELD, CALIFORNIA

COCCIDIOIDOMYCOSIS is produced by a specific fungus, *Oidium coccidioides* or *Coccidioides immitis*, as first suggested in 1896 by Rixford and Gilchrist.⁵ Ophüls and Moffit⁶ reported a case in 1900 and were the first to demonstrate the organism to be a mold. The infectious form in animals, parasitic phase, is a spherule with a double refractile wall. These may vary in size from 10 to 200 microns in diameter. Within the spherule numerous endospores are formed which are released to spread within the animal host by way of the blood stream or lymphatics when the wall of the spherule ruptures. The saprophytic phase consists of long septate hyphae producing a mycelium.

The disease process is endemic in Southern California in the Central Valley and the Mojave Desert. Cases have been reported from Arizona, as well as from various parts of the country. During World War II, many thousands of troops were stationed or underwent training in endemic areas of California and were exposed to possible infection by the coccidioidomycosis. Hundreds of migrant agricultural workers, drawn from the racial groups which are the most susceptible to the disease process, are exposed to infection every year in Kern County.

In 1931, Carter^{2,3} reported on 50 cases of coccidioidal granuloma in bone, among whom there were 94 lesions. He described in detail the sites of involvement. In 1934, he³ again reported on the cases which he had seen up to that time, now amounting to 70.

Benninghoven and E.R. Miller¹ reviewed the cases up to December, 1941, at Kern General Hospital, Bakersfield, and included them in their review along with cases from Los Angeles County Hospital and Stanford Hospital.

We have collected 17 cases (Table I)

from July, 1942, to October, 1947, illustrating bone lesions of coccidioidal granuloma and which were confirmed clinically by skin tests, serological study, biopsy, culture or on sections taken at autopsy.

The cases were all positive for either one or more of the above tests.

As can be seen from Table I, there were 8 Negroes, 4 Filipinos, 3 white persons, 1 Mexican, and 1 Chinese. This is consistent with the findings of other observers that the most susceptible individuals are members of the colored races.

The duration of symptoms before the patient presented himself with complaints involving the osseous system varied from thirty days (Case 7) to sixteen years (Case 2).

At the time the examinations of the bone lesions were made there was lung involvement in 9 of the cases. Pulmonary involvement was not present in 8 of the cases.

Table II shows the distribution of lesions among bones.

Case 7 (Table I), a Filipino, aged thirty-four, developed a painless, growing mass over the right sternoclavicular joint thirty days before presenting himself for treatment. On roentgen examination, there was involvement of the medial end of the clavicle.

All bone lesions showed marked variations similar to those described by Benninghoven and Miller,¹ and Carter.^{2,3} However, in our series, there was no bone involvement caused by extension from a soft tissue abscess or granuloma in the region of the bony structure. This is contrary to the findings of Carter and Benninghoven and Miller who stated "that there was invasion of underlying bony structure by extension from an overlying abscess". On the other hand, in our series of bone cases, the bone lesions may cause the soft tissue involvement which will go on to ulceration and

TABLE I

Case	Race	Age	Duration	Lung Involvement	Bone Lesions	Skin Test	Serological Findings	Other Laboratory Procedures
1—A.W. Male	Colored	24 yr.	7 mo.	Positive	Single rib, 5th left side, ant.	Negative	Positive on 2-13-47 and 3-19-47 with increasing titer	
2—W.H. Male	Colored	21 yr.	16 yr.	Negative	Lumbar spine, ant.	Positive	Positive	
3—B.A. Male	Colored	15 yr.	22 mo.	Negative	2nd metacarpal 5th metatarsal	Negative	Positive	Sequestrectomy 2nd metacarpal
4—I.A. Male	Filipino	38 yr.	6 wk.	T.B. neg. cocc.	Navicular, patella left leg; femur left leg	No record	No record	Surgical removal of navicular; showed microscopic positive for coccidioidomycosis
5—W.V. Male	White	42 yr.	4 yr.	Positive	Talus, navicular left foot; patella right knee; lat. condyle rt. elbow	Positive	Positive	
6—L.C. Female	Colored	9 yr.	7 yr.	Negative	Multiple bone involvement, especially T ₁₂ and L ₁	Positive	No record	
7—B.U. Male	Filipino	34 yr.	30 days	Positive	Rt. sternoclavicular joint; medial end clavicle	Negative	No record	Aspiration biopsy of mass of clavicle with positive culture
8—F.L.N. Male	White	33 yr.	5 yr.	Positive	Left ilium	Positive	Positive	Positive culture
9—M.A.M. Female	White	69 yr.	2 mo.	Positive	Skull, left tibia	Negative	Died	Sections of lesions positive for coccidioidal granuloma of bone
10—E.N. Female 6 mo. pregnant	Colored	37 yr.	3 mo.	Positive	T ₆ ; T ₈ ; L ₂	Negative	Positive	Biopsy of ilium positive; autopsy specimen
11—C.B. Female	Colored	37 yr.	4 wk.	Positive	L ₄ ; S ₁ ; S ₂ ; sternum	Negative; Mantoux positive	No record	Autopsy
12—G.W. Male	Colored	38 yr.	2½ mo.	?	Distal end radius	Positive	Positive	Culture positive
13—M.L. Female	Chinese	65 yr.	6 mo.	Positive	Both knees, patellae, tibiae and femur	No record	No record	Culture positive
14—A.B. Male	Filipino	41 yr.	2 mo.	Positive	L ₁ , L ₂	Positive	Positive	Culture positive
15—J.S. Male	Filipino	30 yr.	4 mo.	Positive	Cuboid; distal third of clavicle	Positive	Positive	Positive on examination of smear
16—R.E. Male	Mexican	26 yr.	1 yr.	Positive	Lumbar spine L ₁ to L ₄	No record	Positive	Autopsy
17—J.S. Female	Colored	26 yr.	4 mo.	?	Sternum	Negative	Positive	Autopsy; microscopic sections positive

subsequent abscess formation.

In 6 cases the skin test was negative in dilutions as low as 1 to 100 for coccidioides, while the serological test was positive in

every case in which the serological examination was done. All serological tests were performed by Dr. C. E. Smith, of Stanford Medical School. In our series of cases, a negative coccidioidin skin test may be of no value in ruling out the disease process. Serological tests, cultures and biopsies are

TABLE II

DISTRIBUTION OF LESIONS AMONG BONES

Skull	1	Tarsal navicular	1
Clavicle	2	Cuboid	1
Radius	1		
Metacarpal, 2nd	1	Vertebral column:	
Metatarsal, 5th	1	T-6	1
Sternum	2	T-8	1
Ribs	1	T-12	1
Ilium	2	L-1	1
Femur	4	L-2	2
Patella	3	L-3	3
Tibia	3	L-4	3
Fibula	1	S-2	1

TABLE III

Age Groups	No. of Cases
1-10	1
11-20	1
21-30	4
31-40	7
41-50	2
51-60	0
61-70	2

invaluable aids in establishing the diagnosis of coccidioidomycosis.

The age distribution shows that the majority of cases of disseminated coccidioidomycosis occur mostly in the third and fourth decades; that is, when an individual's activity is greatest (Table III).

From Table I we have selected certain cases for illustration.

REPORT OF CASES

CASE I. A. W. This patient was first seen in January, 1947, with chief complaints of pain between the shoulder blades of about four days' duration. Previous to this he had had a slight cold which had been present for about five weeks. Pain in the back was much worse on breathing, was fairly steady and did not radiate. The patient had a slight cough and temperature of 101° F. There was no hemoptysis. There had been about a 15 pound weight loss in the month previous to admission.

Physical findings revealed dullness over both lower lung fields, diminished breath sounds, especially on the left, and bronchial breathing in the right lower lung field. Roentgen examination at this time showed some infiltration in both lower lung fields. Figure 1 shows a roentgen study of the chest taken on February 11, 1947. There were a few linear densities in the



FIG. 1. Case I. Shows pneumonic infiltration, left lower lung field, extending down from left hilar area to involve lower half of left lung.



FIG. 2. Case I. Shows a clearing of infiltration in left lower lung field but with beginning erosion of the fifth rib along the superior margin anteriorly.

right base; however, there was a marked infiltration in the left lower lung field which had the appearance of a consolidation.

The patient developed nodules in the antecubital fossa of the right arm, and in the middle third of the right leg. On February 19, 1947 biopsies were taken. The microscopic report showed an inflammatory granuloma. Serological tests for coccidioidal infection, done on February 21, 1947, revealed a complement fixation which was positive for coccidioides. There was subjective improvement during the patient's stay in the hospital. Pain in the left leg gradually disappeared. A follow-up visit in the Chest Clinic on April 10, 1947, and a roentgen study of the chest at that time, showed that the inflammatory process in the left lower lung had almost disappeared. In Figure 2 it can be noted that there was beginning erosion of the fifth rib on the left side, anteriorly.

Toward the end of April, a lump on the anterior left lower chest was discovered which was a little larger than the size of an egg. At about this same time, swelling of the right thigh developed. On May 6, 1947, further roentgen studies of the chest revealed an increase in the erosion of the fifth rib. Soon after this, the lump in the anterior left lower chest went on to abscess formation and suppuration, and began to drain. Marked erosion of the fifth rib, left side, was

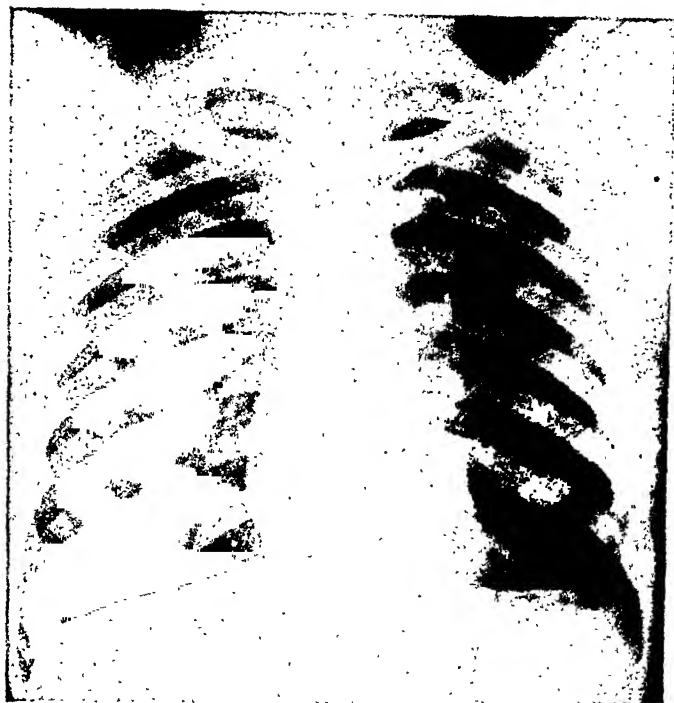


FIG. 3. Case 1. Shows the increase in the erosion of the fifth rib, which is now quite marked.

again demonstrated in the roentgen study made on September 11, 1947.

Comment. This case illustrates the resolution of the pulmonary involvement by coccidioides, but there was evidently a hematogenous spread localized to the fifth rib on the left side, as well as to various

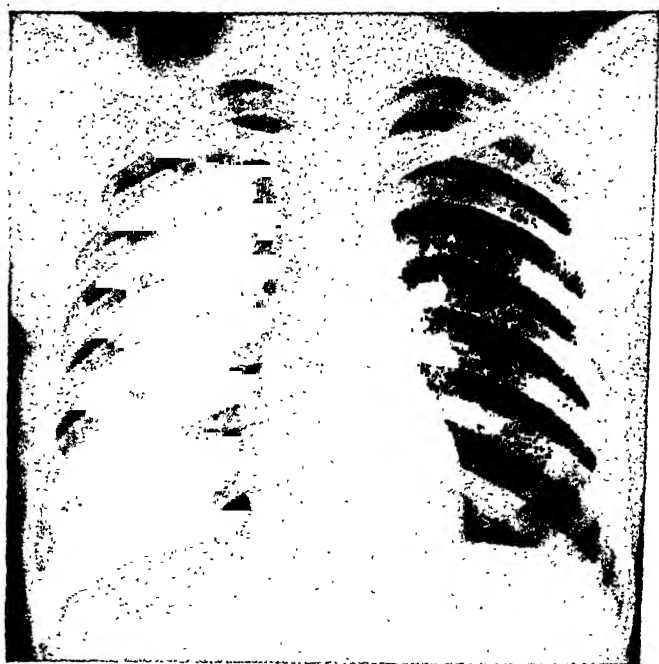


FIG. 4. Case 1. This roentgenogram illustrates the destruction of two-thirds of the anterior portion of the fifth rib on the left side.

parts of the soft tissues, as this rib had undergone destruction. There was no bone production—only bone destruction. There was spread of the disease process from the bone to the overlying soft tissues with subsequent abscess formation, suppuration and ulceration.



FIG. 5. Case 1. Shows an area of necrosis and ulceration in the left lower chest, region of the fifth rib.

CASE 2. H. W., a Negro male, aged twenty-one, who had been a resident of Kern County since 1926. History revealed that since the age of five years he had been having granulomatous lesions appearing in various parts of the body which would go on to abscess formation and suppuration. Serological tests had been positive. Patient was seen on September 9, 1947, complaining of pain in the lumbar area, of only four weeks' duration. Figure 6 reveals involvement of the anterior surfaces of the third, fourth and fifth lumbar vertebrae, which may well represent calcifications in the soft tissues.

Patient had multiple draining sinuses along the anterior and medial surfaces of the thighs, and there appeared to be some soft tissue calcification along the anterior surfaces of the third, fourth and fifth lumbar vertebrae (Fig.

6). It was noted that although this patient had areas of ulceration in the lumbar area posteriorly there was no involvement of the posterior surfaces of the lumbar vertebrae. Roentgen examination of the left femur (Fig. 7) showed some calcific densities in the soft tissues along the medial surface, but the femur itself was not



FIG. 6. Case 2. Shows the destruction of the anterior surfaces of the third, fourth and fifth lumbar vertebrae, with some sclerosis of the underlying bony structure in the fifth lumbar vertebra. There can be noted also some linear densities anteriorly which may represent calcification in the soft tissue.

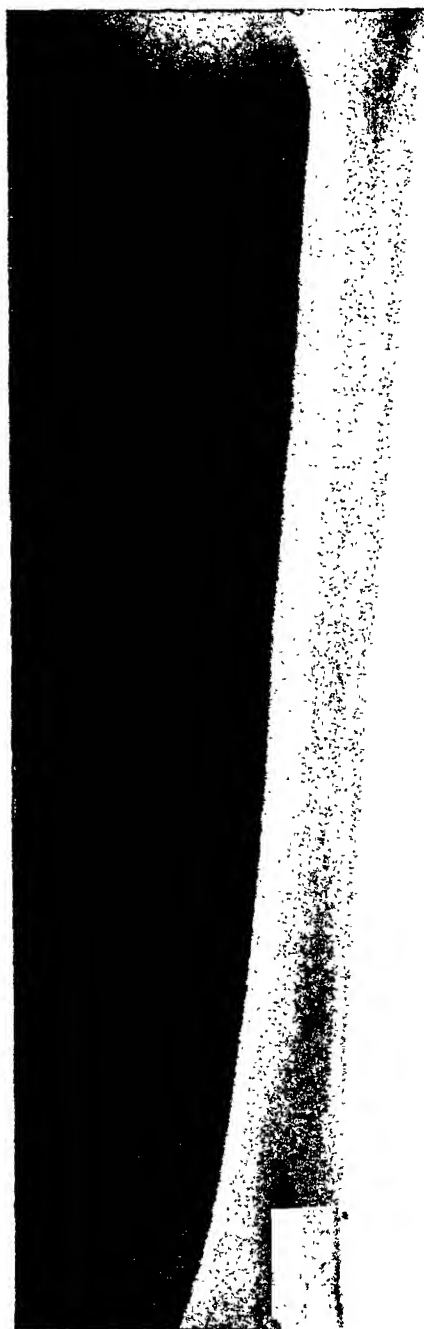


FIG. 7. Case 2. Illustrates densities and linear streaking along the medial surface of the femur, suggesting calcification of the soft tissue. There was no invasion of the underlying bony structure.

involved. Figures 8 and 9 show areas of involvement in the lumbar area, and left thigh.

Comment. This patient had been suffering from disseminated coccidioides for a period of sixteen years. During this time he had shown considerable resistance to the disease process as evidenced by the fact that the serological tests showed evidence of a moderately severe coccidioidal infection only. Evidently he was handling



FIG. 8. Case 2. Shows numerous granulomatous lesions involving the lumbar area, the gluteal regions and the upper portion of both legs. Note the marked ulceration in the region of the fourth and fifth lumbar vertebrae.

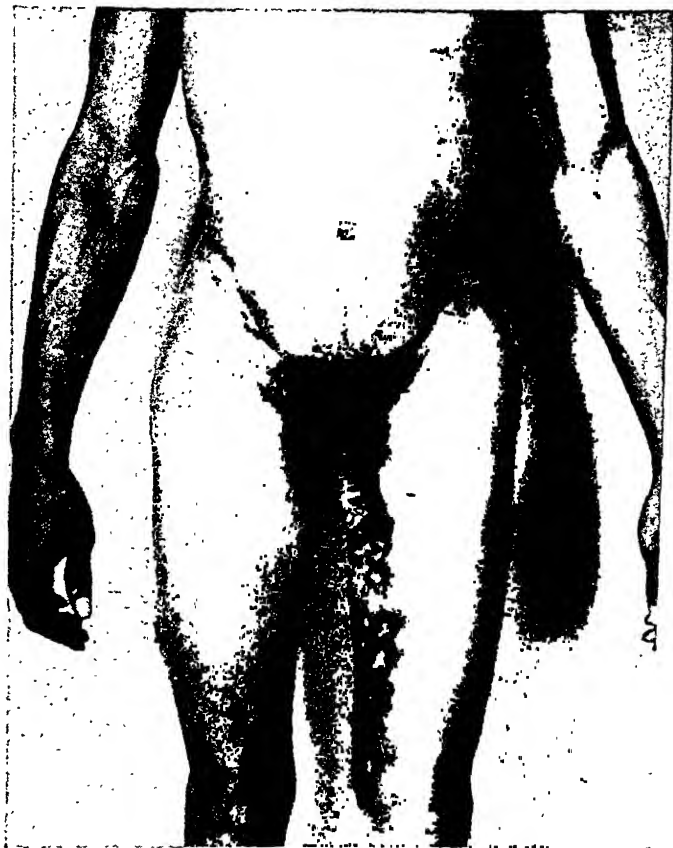


FIG. 9. Case 2. Shows the granulomatous lesions along the medial surface of the left upper leg.

the infectious process fairly satisfactorily. This case illustrates the fact that while there were ulcerating granulomatous lesions involving the soft tissues, the underlying bone structure was not affected.

CASE 4. I. A., a Filipino, aged thirty-three, who had been under treatment for pulmonary tuberculosis since 1939. He was first seen in Kern General Hospital on July 27, 1946, with chief complaints of frequency of urination, fever and nocturia of one month's duration.

Cystoscopic examination revealed findings suggestive of possible tuberculosis involving the bladder. Patient returned to the sanatorium.

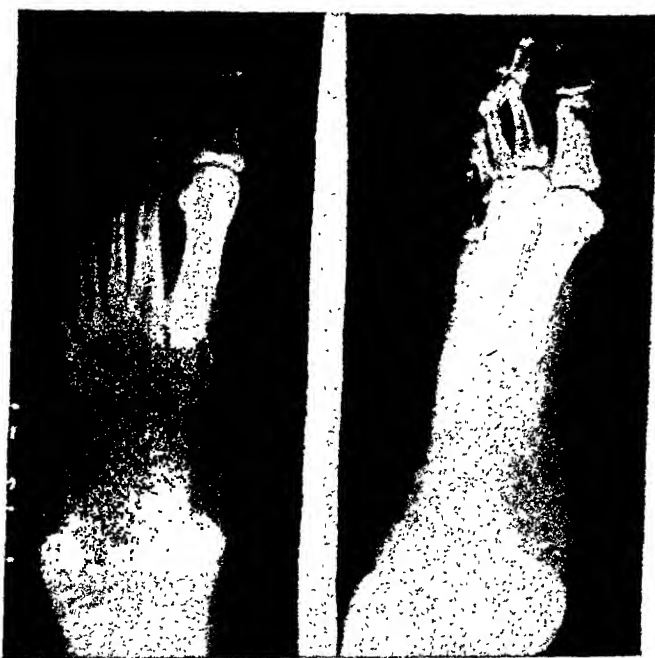


FIG. 10. Case 4. Shows an osteolytic area in the medial portion of the navicular with breaking down of the margin. There is also noted marked calcification of the digital vessels.

He was next seen on January 13, 1947, in the Orthopedic Clinic with complaints of swelling of the medial and dorsal surfaces of the left foot. The swelling had been present for about six weeks before admission and had been increasing slowly until the time of examination. The swollen area extended from the toes to above the ankle and was somewhat tender on palpation and warm to touch. Roentgen examination of the foot (Fig. 10) showed a radiolucent area in the navicular bone, marked thinning of the cor-

tical bone, and a break in the cortex medially. There was also noted marked sclerosis of the digital vessels. Further roentgen studies, made on January 29, 1947, showed an increase in the destructive process involving the navicular bone.

On March 6, 1947, the navicular bone was excised.

Pathological report showed "considerable necrosis with extensive granulation tissue characterized by the formation of typical tubercles with Langhans' giant cells, epithelioid cells and surrounding rings of lymphocytes. There were occasional double contoured spherules seen which established the etiology of coccidioidal granuloma of bone."

On March 31, 1947, the patient complained of pain about the left knee. An area of demineralization and destruction of the cortical bone involving the patella was demonstrated on roentgen study (Fig. 11), with radiolucent areas in the lower end of the femur. These findings evidently represented a spread of the disease process to involve the patella and the lower end of

the femur. There was a lapse of approximately three weeks from the time of operation and the findings in the left knee.

Comment. The patient was suffering from two lesions of a granulomatous nature—tuberculosis and coccidioidomycosis. The diagnosis of coccidioidomycosis was established by the findings of double contoured spherules in the sections taken from the tarsal navicular bone.



FIG. 11. Case 4. Shows bone destruction of anterior surface of patella, posterior surface of tibial plateau, and also bone destruction at the lower end of the femur.

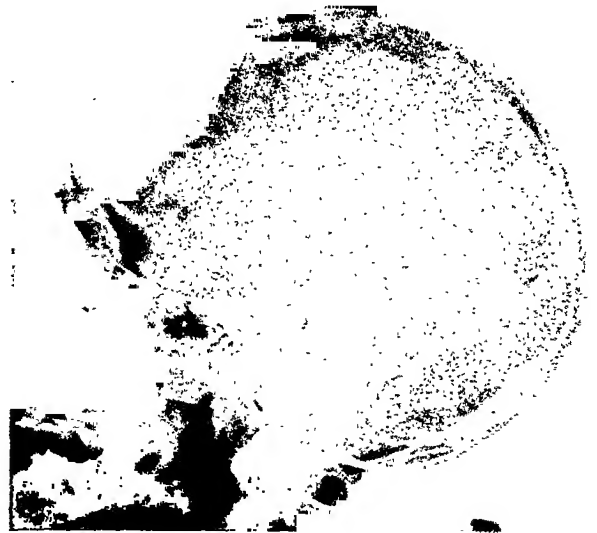


FIG. 12. Case 9. Shows the marked destructive lesions involving the calvarium.



FIG. 13. Case 9. Shows the marked destructive lesions of the calvarium.

This illustrates the possible spread by surgical intervention, since experience with this disease shows that the best results are obtained by non-surgical methods.

CASE 9. M. A. M., a white female, aged sixty-nine, who had been in Kern County for nine years. Admitted to the Hospital with a diagnosis of coccidioidal granuloma. History revealed that she had been ill for about five or six weeks previously and had been undergoing treatment in another hospital for lesions on the scalp. She had been discharged from the other hospital and had returned home when she developed a high fever, was mentally confused, and was then admitted to our Hospital.

Examination revealed an elderly female with slight mental confusion and multiple abscesses of the scalp. There was a granulomatous lesion on the right cheek and right side of the nose. The chest was negative on physical examination; however, roentgen studies of the chest showed a diffuse mottling throughout both lung fields which was diagnosed as coccidioidomycosis. Roentgen studies of the skull (Fig. 12 and 13) showed multiple areas of necrosis. Biopsies of these abscess formations on the skull revealed multiple coccidioidal endospores. The patient was skin tested and was negative, even in dilutions of 1 to 100.

Comment. This is the oldest case in our series. It is noted that in this instance the patient had had a negative skin test while suffering from a disseminated granulomatous lesion which, on biopsy, demonstrated *Coccidioides immitis*.

SUMMARY

Seventeen cases of coccidioidal granuloma of bone are presented. These are proved cases seen at Kern General Hospital from July, 1942, to October, 1947. The colored race, Mexicans and Filipinos, are the predominating racial groups that have been shown to be most susceptible to the disseminated lesions. The lesions are seen most often in the third and fourth decades.

Roentgen findings are principally osteolytic, and occasionally there may be some sclerosis. However, in some of our cases

there are suggestive linear calcifications in the soft tissues adjacent to bone. Our findings are at variance with those described by Carter, Benninghoven and Miller insofar as they describe bone involvements secondary to extensions from soft tissue granulomatous lesions. In none of our cases has a soft tissue abscess produced underlying bony invasion. On the other hand, the bone involvement may produce a soft tissue abscess with ulceration.

In many of our cases the primary lung involvement can no longer be demonstrated when the patients are seen with findings of a disseminated coccidioidomycosis.

A negative coccidioidin skin test may be of no, or little value, in making a diagnosis of osseous coccidioidal granuloma.

Serological examination is of diagnostic importance in determining the presence of a disseminated coccidioidomycosis.

Cultures, biopsies and tissues taken at autopsy are of importance in definitely establishing the presence of coccidioidomycosis.

David Miller, M.D.
507 Professional Building
229 North Central Ave.
Glendale 3, Calif.

REFERENCES

1. BENNINGHOVEN, C. D., and MILLER, E. R. Coccidioidal infection in bone. *Radiology*, 1942, 38, 663-666.
2. CARTER, R. A. Coccidioidal granuloma: roentgen diagnosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 715-738.
3. CARTER, R. A. Infectious granuloma of bones and joints, with special reference to coccidioidal granuloma. *Radiology*, 1934, 23, 1-16.
4. GOREN, M. L. Localized coccidioidomycosis of bone. *J. Bone & Joint Surg.*, 1946, 28, 157-160.
5. RIXFORD, E., and GILCHRIST, T. C. Two cases of protozoan (coccidioidal) infection of the skin. *Johns Hopkins Hosp. Rep.*, 1896, 1, 209-265.
6. OPHÜLS, W., and MOFFIT, H. C. A new pathogenic mold (formerly described as a protozoon; *Coccidioides immitis pyogenes*). *Philadelphia M. J.* 1900, 5, 1471-1472.
7. ROSENBERG, E. F., DOCKERTY, M. B., and MEYERDING, H. W. Coccidioidal arthritis. *Arch. Int. Med.*, 1942, 69, 238-250; correction, 1942, 69, 717.

CALCIFICATION IN INTRASPINAL MENINGIOMAS

By GORDON J. CULVER, M.D., JOSEPH P. CONCANNON, M.D., and E. C. KOENIG, M.D.

Department of Roentgenology, Buffalo General Hospital

BUFFALO, NEW YORK

ALTHOUGH abnormal calcification of the skull has long been of value to the roentgenologist in the diagnosis of intracranial neoplasms, it has rarely been helpful in the diagnosis of intraspinal tumors. Chief interest in the diagnosis of intraspinal tumors has been centered on erosion of the pedicles, increase in interpedicular distance, and changes in the intervertebral foramina, little attention being given to calcification within the vertebral canal.

Sporadic case reports have appeared in the literature concerning calcification within the spinal column seen on roentgenograms.^{1,2,3,4,6,7,11,12,13,15} Dyke⁵ referred to this calcification by saying: "When a definite, irregular mass of lime is seen within the spinal cord, the location and type of tumor has been determined, for in this clinic such an irregular mass of calcification has always proven to be within a meningioma." Brown³ estimates that 15 per cent of intraspinal meningiomas are of the psammomatous or osteoblastic type, and that 4 per cent of these types should be visible on the roentgenogram.

It is the purpose of this paper to present 5 cases of intraspinal meningiomas which contained sufficient calcification to be visible on roentgenograms of the spine. No calcification was seen within any intraspinal tumor other than meningioma.

During the years 1937-1947, inclusive, there were 54 intraspinal neoplasms seen at the Buffalo General Hospital on the neurosurgical service of Dr. Wallace Hamby, 15 of which were meningiomas.

REPORT OF CASES

CASE I. R. C., a female, aged fifty-seven, noticed in 1929 that her feet felt numb and heavy, and that her steps had become awkward and jerky. This persisted until time of admission, in 1939.

On May 2, 1939, myelography of the spine showed an almost complete block to the column of lipiodol at the level of the sixth dorsal vertebra. Overlying the body of the fifth dorsal there was an oval, homogeneous density which appeared to be in the region of the vertebral canal. This could also be seen in the lateral projection. There were no bony changes in the vertebrae.

A dorsal laminectomy was done on May 3, 1939. A friable reddish-gray tumor, which contained an extensive calcium deposit on the right lateral surface of the tumor, was found. The upper pole of the tumor was partially covered by the lamina of the sixth dorsal vertebra.

Pathological Report. The tumor, which measured 3.2 by 1.5 by 1 cm, was grayish-pink in color and microscopically contained bone. Microscopic examination revealed a typical psammoma.

Note: Roentgenograms and pathological section were not available, so illustrations are not included.

CASE II. M. W., a white female, aged forty-three, since 1938 had noticed bilateral weakness in her legs. Since October, 1942, she has had low lumbar pain radiating down her legs, more on the left than on the right.

Myelography done on February 16, 1943, showed a complete block to the column of lipiodol between the tenth and eleventh dorsal vertebrae. Just above the block there was an irregular, flocculent type of density which could conform to calcification within a spinal cord tumor. This calcification, which was well seen on the lateral projection, was barely visible on the anteroposterior projection. There was also a slight widening of the interpedicular distance of the tenth dorsal vertebra, with some flattening of the inner aspect of the pedicle on the right side.

A dorsal laminectomy was done on February 23, 1943. A mass could be palpated through the dura, and this mass was so hard and fixed that it was impossible to introduce the rongeur blade between the dura and the lateral portions of the

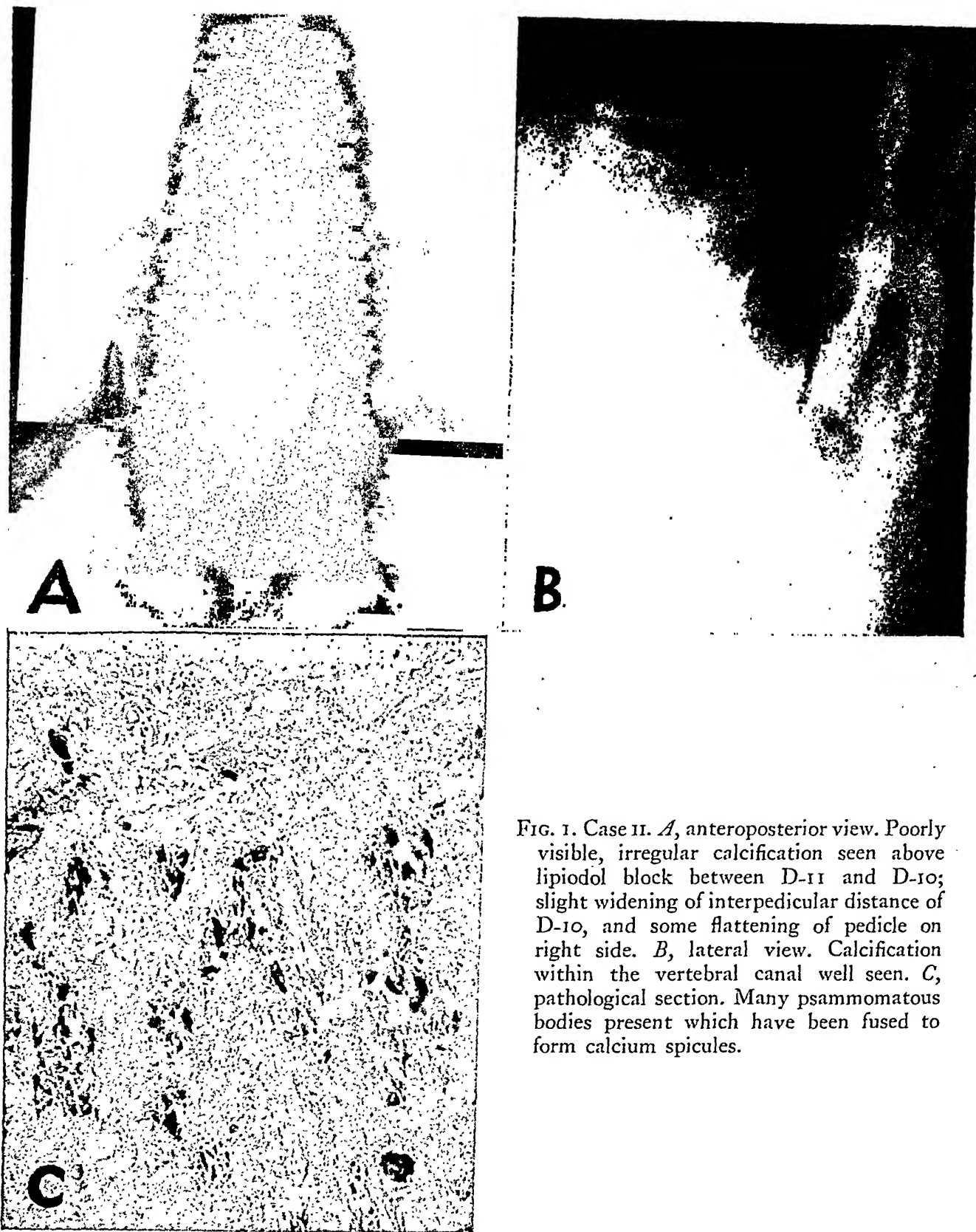


FIG. 1. Case II. *A*, anteroposterior view. Poorly visible, irregular calcification seen above lipiodol block between D-11 and D-10; slight widening of interpedicular distance of D-10, and some flattening of pedicle on right side. *B*, lateral view. Calcification within the vertebral canal well seen. *C*, pathological section. Many psammomatous bodies present which have been fused to form calcium spicules.

laminae of the tenth and eleventh dorsal vertebrae. This mass, which was almost completely calcified, was removed.

Microscopic examination revealed a typical meningioma, moderately cellular, with elongated cells and uniform nuclei. There was frequent whorl arrangement, with a great many psammoma bodies which had fused to form calcium spicules.

CASE III. P. K., a white female, aged thirty-two, had a history of low back pain, with intermittent radiation down the right anterior thigh, with associated numbness and partial paralysis of the left leg, since 1937. In August, 1944, back pain became constant, and weakness of the left leg became pronounced. Since October, 1944, she has been unaware of the sensation of urination or defecation.

Roentgenograms on April 12, 1945, showed an oval-shaped area of homogeneous increased density in the vertebral canal at the level of the twelfth dorsal intervertebral space. This increased density was visible only in the lateral projection of the dorsolumbar spine. There was no increase in the interpedicular distance, no erosion of pedicles or enlargement of intervertebral foramina. Pantopaque spinogram showed complete block in the mid-portion of

right half of abdomen and back. The left leg had a tendency to drag.

A pantopaque spinogram was done on November 11, 1946, which showed practically complete block at the level of the fifth dorsal vertebra; only a few drops of pantopaque passed this area. A tumor mass could be outlined on the right side of the canal, measuring approximately 2.5 cm. in length by 1.5 cm. in thickness. There was faint homogeneous calcifi-

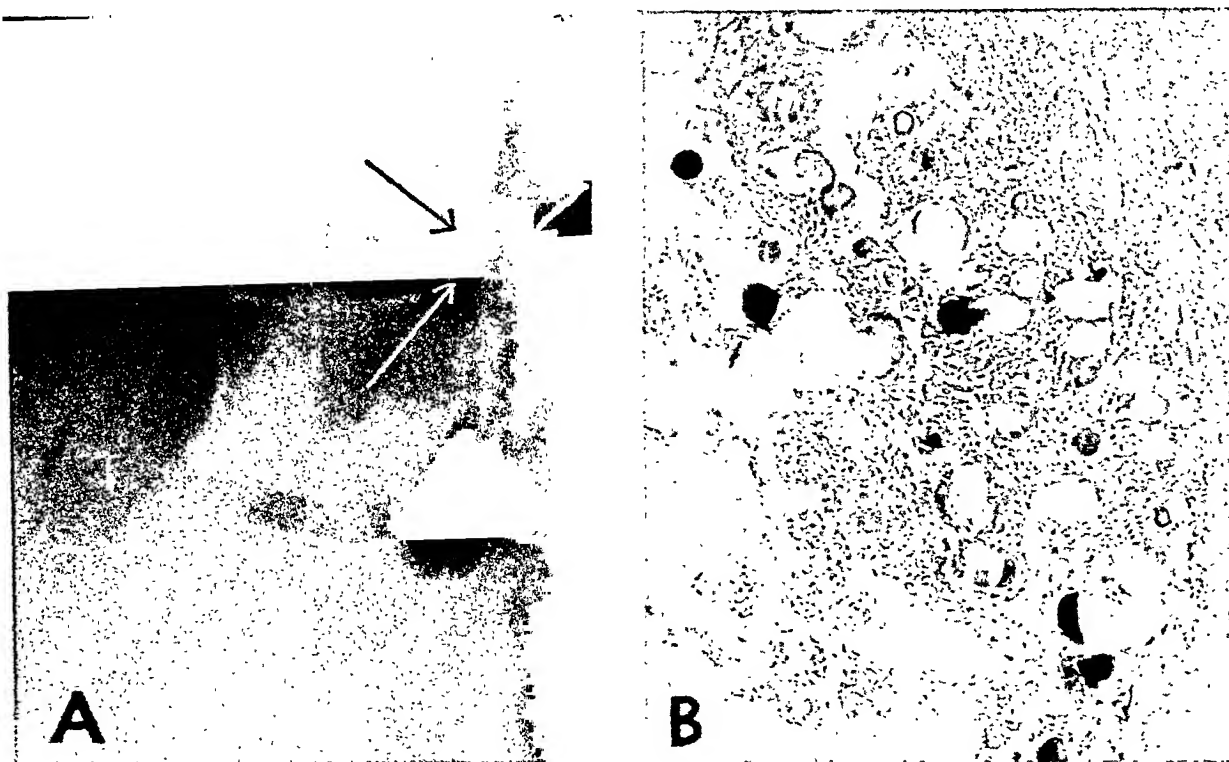


FIG. 2. Case III. *A*, well defined oval mass of increased density at the level of the twelfth dorsal intervertebral space. This was not visible in the anteroposterior projection. *B*, pathological specimen. Numerous psammoma bodies with distinct calcification.

the first lumbar vertebra, with concave surface of pantopaque column at the block.

On April 24, 1945, a laminectomy was done. A pinkish-gray, friable, encapsulated neoplasm lying in the right anterolateral quadrant of the canal at the twelfth dorsal and first lumbar vertebrae was found, and removed.

Microscopic examination showed a moderately cellular meningioma, with frequent whorl arrangement. Numerous psammoma bodies were present, with distinct calcification.

CASE IV. A. H., a white female, aged forty-six, began to complain of sensation of warmth and numbness in right foot and leg, in August, 1946, which gradually ascended to the hip and

cation in this tumor mass. There was no change in interpedicular distance, no erosion of pedicles or enlargement of intervertebral foramina.

On December 12, 1946, a laminectomy was done. At the level of the fifth dorsal vertebra a small oval-shaped tumor compressing the cord was found, which was removed.

Microscopic examination revealed a highly cellular meningioma, with elongated cells with round and oval nuclei. The predominant feature in this tumor was the frequent whorl arrangement, with frequent psammoma bodies and moderate calcification.

CASE V. E. R., a white female, aged fifty-two, with a history of intermittent pain in the right

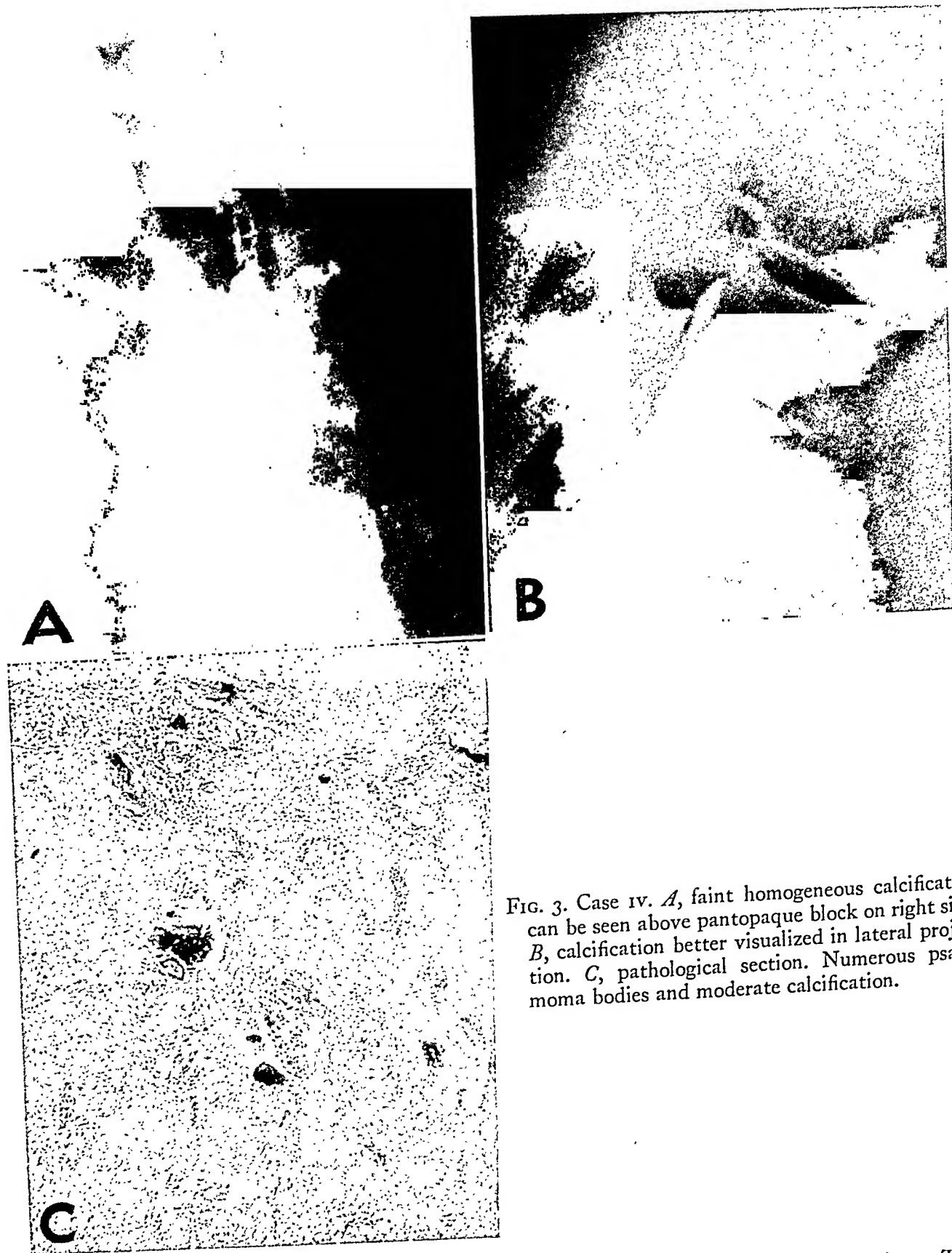


FIG. 3. Case IV. *A*, faint homogeneous calcification can be seen above pantopaque block on right side. *B*, calcification better visualized in lateral projection. *C*, pathological section. Numerous psammoma bodies and moderate calcification.

leg and difficulty in walking due to weakness, since 1944.

Roentgenograms of the dorsal spine, June 20, 1947, showed a calcified tumor lying in the region of the vertebral canal at the level of the sixth dorsal vertebral body. This measured about $\frac{1}{2}$ inch in length, and was visible in both

anteroposterior and lateral projections. There were no bony changes in the vertebrae. Pantopaque spinogram showed almost complete block to pantopaque at the lower border of the sixth dorsal vertebra. A small amount of contrast material passed the block. The block was at the lower level of the calcified tumor mass

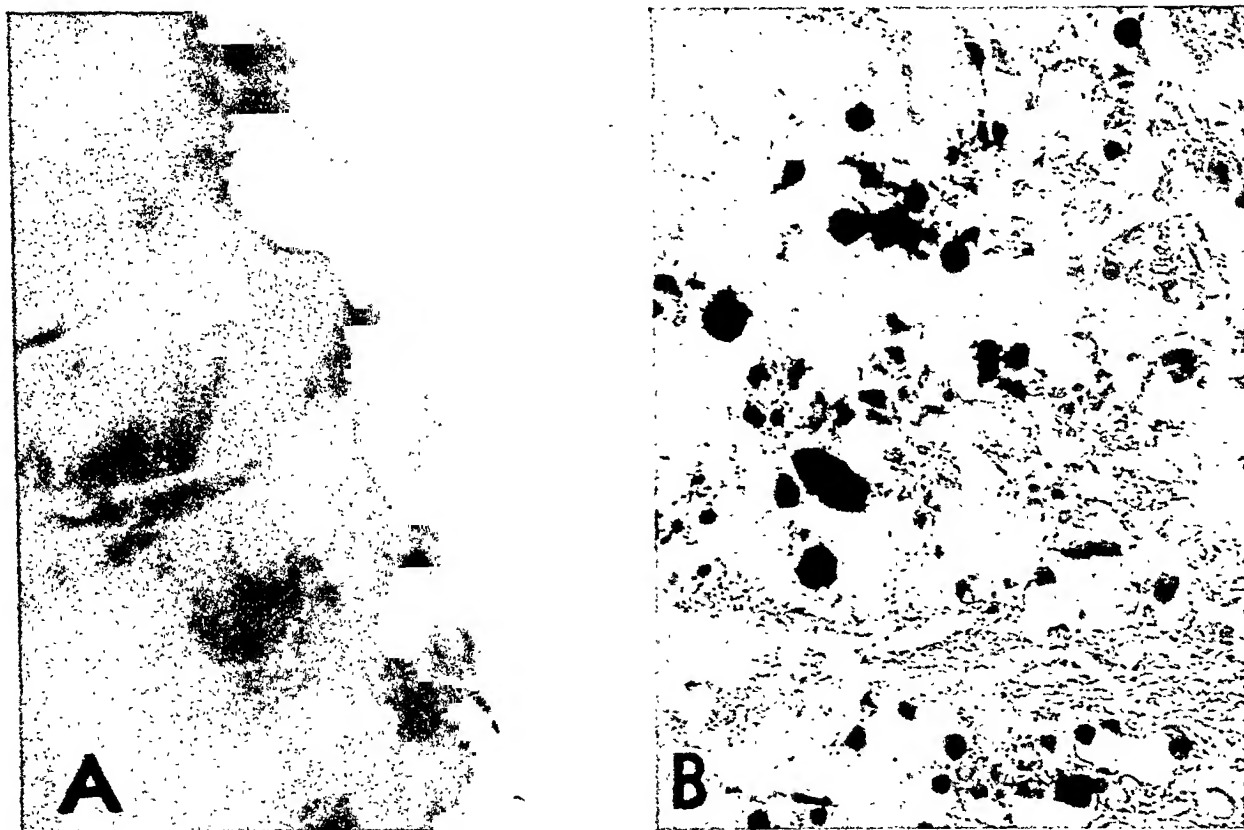


FIG. 4. Case v. *A*, calcified tumor seen above pantopaque block. *B*, pathological section. Many calcified masses scattered in the stroma.

which was seen on the plain roentgenogram.

Dorsal laminectomy was done, June 24, 1947. An extensively calcified tumor was removed from the left anterolateral aspect of the canal.

Microscopic examination revealed an ossifying meningioma with many bony trabeculae being laid down in a meningiomatous stroma. In some places there were calcified psammoma bodies scattered in the stroma. Another section showed only endothelial-like cells enclosing many markedly calcified bodies.

DISCUSSION

Extramedullary, intradural spinal tumors form 60 per cent of all spinal tumors, and intraspinal, extradural tumors constitute 20 per cent. Dyke⁵ estimates that 25 per cent of extramedullary, intradural tumors may be localized roentgenographically by the changes they produce in contiguous vertebrae and surrounding soft tissues, while as many as 80 per cent of the extradural, intraspinal tumors will produce localizing changes. Camp⁶ further corroborates this by stating that in his series of

164 cases of extramedullary spinal cord tumors, 29.8 per cent of these tumors caused secondary changes in contiguous vertebrae sufficient to permit roentgenological localization of the lesion.

Findings which are of aid to the roentgenologist in the localization and diagnosis of spinal cord tumors are: (1) erosion of pedicles and increased interpedicular distance, (2) bone destruction, (3) distortion of paraspinal soft tissues, (4) bone proliferation, (5) kyphosis and scoliosis, (6) calcification in a tumor. These changes have evoked much comment in the literature, notably by Elsberg and Dyke, and Camp.

Although the over-all incidence of diagnostic roentgen changes in spinal cord tumors is reported as high as 30.3 per cent, it is estimated that it is possible to make a roentgenographic diagnosis of spinal cord tumor in only 8 per cent of meningiomas.⁸ In Camp's⁶ series, 9.3 per cent of meningiomas produced changes in the vertebrae, and, in addition, 2 were calcified; thus,

13.9 per cent of meningiomas were diagnosed in this series.

TABLE I
ROENTGENOGRAPHIC CHANGES IN BONE

	Intradural Intraspinal Tumors	Extradural Intraspinal Tumors	Meningioma
Camp ⁶	21.6%	47.2%	9.3*
Dyke	25.0%	80.0%	

* In addition, 2 were calcified—13.9 per cent.

Meningiomas constitute between 20 and 26 per cent of all spinal cord tumors (Table II), the greater majority of meningiomas being localized to the thoracic vertebrae (Table III).

TABLE II

Author	Spinal Cord Tumors	Menin- giomas	Menin- giomas per cent
Wolf	345	57	22
Elsberg	275	73	26
Rasmussen <i>et al.</i>	557	140	25
Camp ⁶	198	43	22

A typical meningioma is a discrete encapsulated tumor, of an oval or spherical shape. The spinal, as well as the intracranial, meningiomas are believed to originate from clusters of arachnoidal cells. Microscopically, a meningioma consists of elongated fibroblastic cells with frequent whorl arrangement. Progressive degeneration with fibrosis, hyalinization and calcification of these whorls are common, resulting in the formation of psammoma bodies. In Wolf's series of 57 meningiomas, the

psammoma bodies were present in 51; were abundant in 25; and in 6 tumors they were particularly abundant. Where these psammoma bodies are particularly numerous, they have a tendency to fuse and form calcium spicules. Actual ossification has been described in intraspinal meningiomas by Bailey and Bucy,² Brown,³ Cushing and Eisenhardt,⁷ Wolf¹⁷ and Rogers.¹⁶

Calcification within spinal cord meningiomas is of three general types. The formation of numerous psammoma bodies results in a homogeneous increase in the density of the tumor, so that on the roentgenogram the tumor is visible only as an ovoid area of increased density. This type of calcification is rarely visible in the anteroposterior projection, but is discernible in the lateral projection of the spine. When the psammoma bodies are particularly abundant, numerous flecks of calcium are visible on the roentgenogram. If the psammoma bodies fuse to form calcium spicules, or actual osteoblastic activity takes place to form bone, a sharp, discrete, irregular mass of calcification may be seen on the anteroposterior and lateral roentgenograms.

A survey of the literature shows that calcification in a spinal cord tumor has proved to be within a meningioma, with rare exceptions. Gray¹¹ has reported a case showing calcification in the roentgenogram which was subsequently thought to be a vascular oligodendroglioma, or an heman-gioblastoma. Rawling¹⁵ has reported a case of teratoma which contained sufficient calcium to be seen on the roentgenogram.

There are probably several reasons why calcification in intraspinal meningiomas is not recognized more frequently on roent-

TABLE III
LOCATION OF MENINGIOMAS

Author	Total Meningiomas	Cervical	Thoracic	Lumbar	Lumbosacral
Elsberg	73	10	59	4	0
Brown	130	25	101	4	1
Rasmussen <i>et al.</i>	140	23	115	6	0

genograms, in spite of the fact that a high percentage are known to contain some calcium:

(1) The calcification frequently is not seen as a definite mass, but only as an area of slightly increased density because of the fine psammomatous type of calcification. The lateral views of the spine are frequently not scrutinized carefully enough for such minor changes.

(2) In other tumors the calcification is not sufficient to be visible, regardless of quality of roentgenogram or interpretation.

(3) The shadows of ribs superimposed upon the vertebral canal of the dorsal and upper lumbar vertebrae make visualization of small areas of increased density difficult.

(4) The technical difficulty in obtaining adequate lateral views of the upper three to four dorsal vertebrae, where so many meningiomas occur. Tomography may be of some value for better visualization of this region, in cases of suspected spinal cord tumors. Gray¹¹ reported a case in which the ordinary lateral and oblique views were not quite conclusive in proving the position of the calcification seen overlying the body of the third dorsal vertebrae in the anteroposterior view, but by tomography was able to prove that it lay within the vertebral canal.

SUMMARY

1. For all practical purposes, a calcified intraspinal tumor is a meningioma.

2. Out of a total of 15 meningiomas, five (or 33.3 per cent) contained sufficient calcium to show on the roentgenogram.

3. Homogeneous increase in density of a meningioma associated with psammomatous calcification will only be seen in a lateral roentgenogram of the spine. Probably more careful search for this type of calcification would result in an increase in the percentage of intraspinal meningiomas diagnosed preoperatively.

Buffalo General Hospital
Buffalo 3, New York

REFERENCES

1. ANTONS, K. Calcified spinal meningioma visible on roentgen film. *Acta psychiat. et neurol.*, 1944, 19, 5-9.
2. BAILEY, P., and BUCY, P. C. Origin and nature of meningeal tumors. *Am. J. Cancer*, 1931, 15, 15-54.
3. BROWN, M. H. Intraspinal meningiomas; clinical and pathologic study. *Arch. Neurol. & Psychiat.*, 1942, 47, 271-292.
4. BUCHSTEIN, H. F. Meningiomas of spinal cord. *Minnesota Med.*, 1941, 24, 539-545.
5. CAMP, J. D. Significance of osseous changes in roentgenographic diagnosis of tumors of spinal cord and associated soft tissues. *Radiology*, 1934, 22, 295-303.
6. CAMP, J. D. Roentgenologic localization of tumors affecting the spinal cord. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 40, 540-544.
7. CUSHING, HARVEY, and EISENHARDT, LOUISE. Meningiomas. Charles C Thomas, Springfield, Ill., 1938.
8. DYKE, C. G. Roentgen Ray Diagnosis of the Spinal Cord, Meninges and Vertebrae. In: *Surgical Diseases of the Spinal Cord, Membranes, and Nerve Roots*. By Elsberg, C. A. Paul B. Hoeber, Inc., New York, 1941, pp. 42-122.
9. ELSBERG, C. A., and DYKE, C. G. Diagnosis and localization of tumors of the spinal cord by means of measurements made on x-ray films of vertebrae, and correlation of clinical and x-ray findings. *Bull. Neurol. Inst. New York*, 1933-1934, 3, 359-394.
10. ELSBERG, C. A. *Surgical Diseases of the Spinal Cord, Membranes, and Nerve Roots*. Paul B. Hoeber, Inc., New York, 1941.
11. GRAY, E. D. Calcification and ossification of spinal tumours. *Brit. J. Radiol.*, 1942, 15, 365-369.
12. ORMOS, M. Positive roentgen shadow of extramedullary (psammous) meningioma. *Schweiz. Arch.f. Neurol. u. Psychiat.*, 1939, 44, 309-312.
13. OSGOOD, E. C., ARNETT, J. H., and LEWY, F. H. Calcified spinal meningioma. *Radiology*, 1944, 43, 62-64.
14. RASMUSSEN, T. B., KERNOHAN, J. W., and ADSON, A. W. Pathologic classification, with surgical consideration, of intraspinal tumors. *Ann. Surg.*, 1940, 111, 513-530.
15. RAWLING, L. B. Spinal tumour seen on direct x-ray examination without lipiodol. *Brit. J. Surg.*, 1932-1933, 20, 348-351.
16. ROGERS, LAMBERT. Spinal meningioma containing bone. *Brit. J. Surg.*, 1927-1928, 15, 675-677.
17. WOLF, A. Tumors of the Spinal Cord, Nerve Roots and Membranes: Pathology. In: *Surgi-*

cal Diseases of the Spinal Cord, Membranes, and Nerve Roots. By Elsberg, C. A. Paul B. Hoeber, Inc., New York, 1941.

SUPPLEMENT

The paper as presented above has undoubtedly given the impression that calcified spinal lesions are in most instances meningiomas. We had purposely excluded calcified herniated intervertebral discs, because previously such intraspinal calcifications had never offered any serious diagnostic problem. This is probably due to the fact that 90 per cent of disc protrusions occur in the lumbar area, and the majority of the remainder in the cervical region. Also, most reported cases of calcifications in intraspinal location in such cases have been in the low lumbar area. Our experience has been similar.

Calcification in the intervertebral disc has been described by Schmorl,²⁰ both in its normal position and in herniated position. He presented roentgenograms of anatomical specimens to illustrate this phenomenon. Brooke¹⁸ presented a case in which a traumatic herniation of an ossified nucleus pulposus caused a complete transverse myelitis. At autopsy, flexion of the neck caused loose intervertebral substance to project 1 cm. into the spinal canal. He believed that, if roentgenograms of the neck had been taken in flexion, this ossified material might have been demonstrated. Cohen¹⁹ reported a case of protruded intervertebral disc between the tenth and eleventh dorsal vertebrae. A review of the films after surgery showed what appeared to be a calcified mass between the tenth and

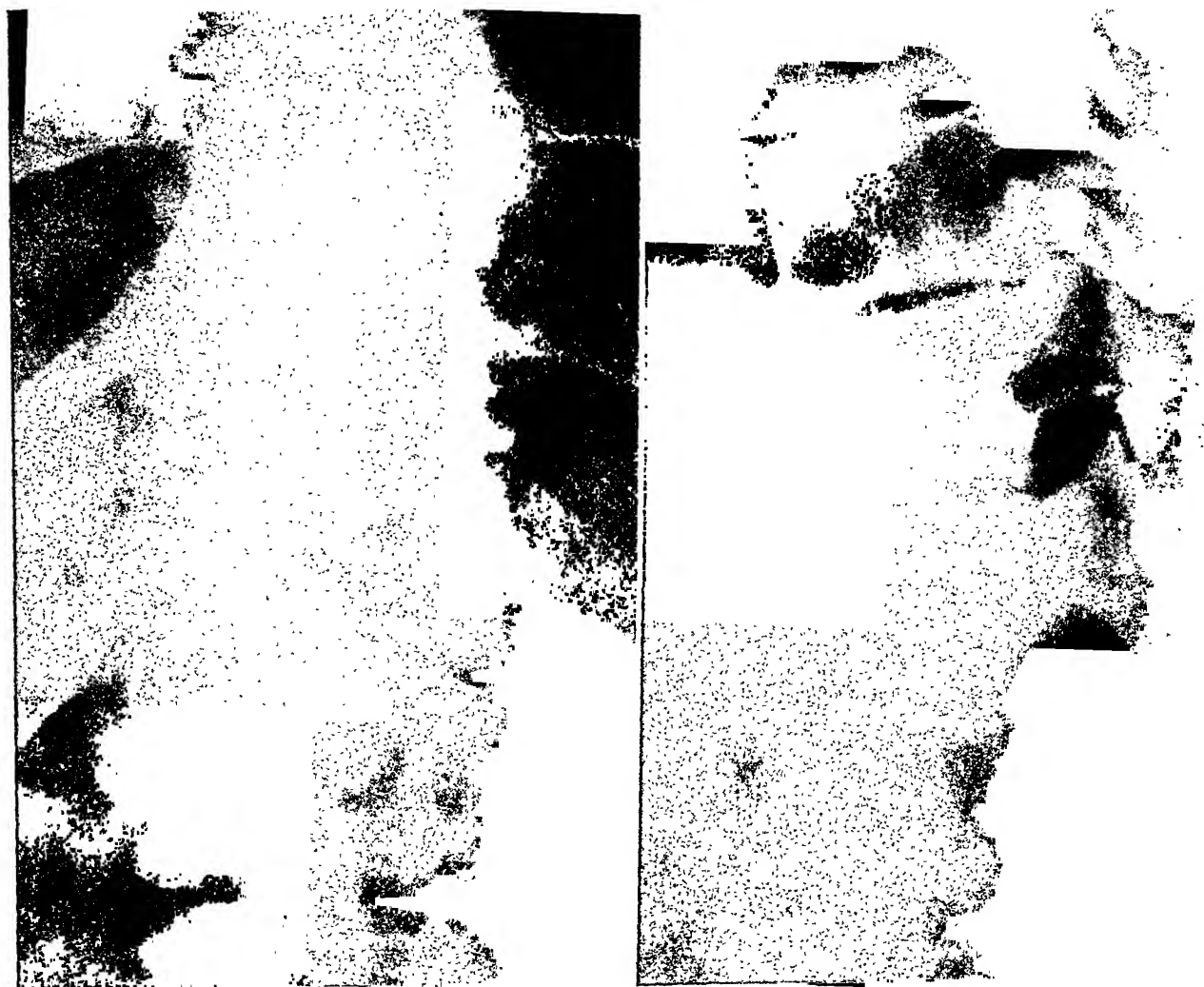


FIG. 5. Anteroposterior and lateral roentgenograms showing calcified intervertebral disc between D-12 and L-1 and the mass of calcification lying posterior to D-10 interspace.

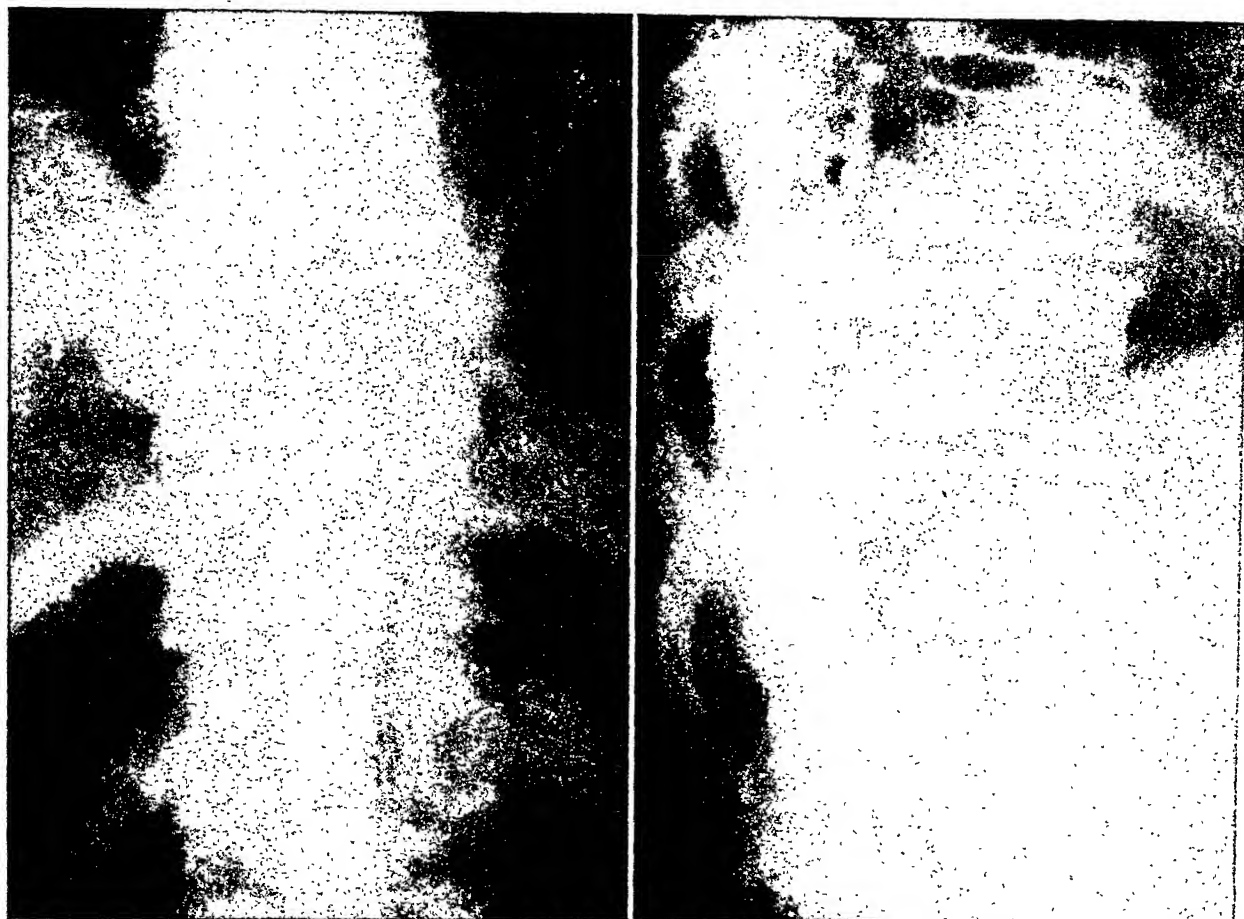


FIG. 6. Anteroposterior and lateral myelograms at same level as the plain films, showing type of displacement occurring. Note particularly the extent of the posterior displacement of the column above and below the lesion, as viewed laterally, rather than the intimate association of contrast material to the lesion which is usually encountered in intraspinal tumors.

eleventh dorsal vertebrae at the site of iodized oil arrest.

Since submission of the above paper, we have observed a case of intraspinal calcification in the dorsal area which occurred in a herniated intervertebral disc. We feel that the rarity of the lesion plus the necessity of including such lesions in a differential diagnosis warrants the inclusion of this case report.

CASE REPORT

CASE VI. V. M., a male, aged fifty-five, who since 1940 had had numbness in the right foot ascending up the right leg, loss of pain and temperature sense in the right lower extremity, and pain in the lower dorsal area. The pain in the back was of a dull, aching nature, which radiated into the right upper abdomen and flank.

Deep reflexes were equal in the upper ex-

trémities. The knee jerk on the right was diminished, and the right ankle jerk was absent. Babinski responses were not present. There was hypalgesia and thermalgesia on the right, involving the right buttock and right leg. Vibration sense was diminished in the right ankle and leg. Motor function was good.

Lumbar puncture revealed initial pressure of 200 mm. Spinal fluid was clear. There was no evidence of subarachnoid block.

Plain roentgenograms showed a calcified disc between the twelfth dorsal and the first lumbar vertebrae. There was also a denser calcification lying posterior to the interspace between the tenth and eleventh dorsal vertebrae. This extended up and down the vertebral canal for about three-quarters of an inch, and was roughly triangular in shape. Pantopaque spino-gram showed only a slight degree of block at the level of the calcified tumor. The pantopaque passed to the left and posterior to the calcified tumor. In the lateral projection the entire

pantopaque column appeared to be displaced posteriorly, and opaque material did not intimately surround the tumor mass. This type of deformity and lack of block was not what is commonly encountered in an extramedullary intradural tumor. This fact, combined with the type and extent of calcification immediately below, led us to consider the possibility of a protruded calcified intervertebral disc.

Decompressive laminectomy of L-1 and D-11, D-12 was done on March 22, 1948. An epidural, stony hard tumor was discovered anterior to the cord. The lesion could not be removed because of venous bleeding secondary to poor respiration. The operating surgeon was convinced that this was a calcified intervertebral disc.

Following surgery, a flaccid paraplegia, right Babinski response and sensory level at D-12 bilaterally was present. On discharge, there was some movement of the ankles in both lower extremities, bilateral Babinski response, flexion withdrawal at stimulation of the right leg, but no change in sensory findings.

DISCUSSION

This case has been added to the above paper for completeness. The occurrence of such lesions in the thoracic area, where most meningiomas occur, is certainly rare, but we now appreciate that they must be considered. Differential points are present which should in most instances establish the diagnosis. While a meningioma may be situated almost anywhere, nearly all herniations are noted opposite the intervertebral discs ventral or anterior to the subarachnoid space; rare exceptions are noted when a disc becomes detached and lies in the epidural space. When calcification is present in a herniated disc, the calcification is usually only a few millimeters in diameter,

opposite the intervertebral space, ventral to the subarachnoid space; and in a fair percentage of cases there may be calcification in the portion of the disc remaining in the intervertebral space. With this calcification there may be some of the associated roentgenographic signs of intervertebral disc protrusion. There may be narrowing of the vertebral interspace, sclerosis of the adjacent vertebral spongiosa, eradication of normal curvature of the spine in the region of herniation, irregularity of the articular margins, proliferation of the articular facets, encroachment on the intervertebral wall by osteophytes. These signs are more common in the cervical area than in the thoracic or lumbar areas. A tumor may erode pedicles or vertebral bodies, and cause increase in interpedicular distance; a herniation never does. Studies with opaque contrast material will be of value in determining whether the calcified mass is extradural or intradural. Only a small percentage of meningiomas are extradural.

It would seem that the illustrations of Case VI (Fig. 5 and 6) will serve best to show the type of calcification and the myelographic changes to be expected in a calcified disc protrusion in the dorsal area.

REFERENCES

18. BROOKE, W. S. Complete transverse cervical myelitis caused by traumatic herniation of an ossified nucleus pulposus. *J.A.M.A.*, 1944, 125, 117-120.
19. COHEN, IRA. Calcified protruded intervertebral disc. *J. Mt. Sinai Hosp.*, 1940, 6, 255-258.
20. SCHMORL, GEORG. Über Knorpelknoten an der Hinterfläche der Wirbelbandscheiben. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1929, 40, 629-634.



INTRACRANIAL CALCIFICATION IN ENCEPHALOTRIGEMINAL ANGIOMATOSIS*

By JOHN G. BIELAWSKI, M.D., and MAURICE TATELMAN, M.D.

DETROIT, MICHIGAN

VASCULAR nevus of the face may be associated with a syndrome characterized by neurological signs referable to a lesion of the cerebral cortex and by an unusual type of intracranial calcification. This syndrome has been described adequately in the neurological literature but has received little attention in the roentgenological periodicals, despite the fact that the roentgenographic findings are often specific.

In 1879 Sturge¹¹ first described the occurrence of epileptiform seizures in association with vascular facial nevus and buphthalmos. Kalischer,⁶ in 1897, described the necropsy findings in a similar case, demonstrating angiomas of the pia over one cerebral hemisphere. Several similar cases were reported in the following years, but it was not until 1922 that roentgenographic evidence of intracranial calcification in this condition was first noted by F. Parkes Weber.¹² Since that time well over one hundred cases of so-called Sturge-Weber (or Parkes Weber-Dimitri) syndrome have been reported showing various combinations of clinical and roentgenographic findings. The following case is reported to emphasize the clinical and roentgenographic findings considered typical of this condition.

CASE REPORT

S. S., female, white, aged twenty-nine, was admitted to the Psychiatric Service of Detroit Receiving Hospital because of auditory and visual hallucinations, and because she was violent and unmanageable at home due to irritability, lack of cooperation, and destructive tendencies.

The patient was born by breech delivery after a difficult labor. The mother noted a large "birthmark" of the upper right face and paralysis of the left arm and leg from birth.

Development was retarded throughout childhood. The patient never attended school and was always shielded from other children. She could speak quite clearly and always recognized members of her family.

Family History. Essentially negative, especially as to cutaneous or neurological abnormalities.

Physical examination revealed a moderately obese female who exhibited definite evidence of mental deficiency. A large nevus venosum covered the right side of the face extending from the hair line to the mouth and from the ear to the midline anteriorly. The right side of the pharynx, uvula, and buccal mucous membranes were similarly involved. The nevus overlapped the midline slightly on the forehead and nose but terminated exactly in the midline of the lip and hard and soft palate. The tongue was uninvolved (Fig. 1). Ophthalmologic examination revealed only some pallor of the optic discs and increased ocular tension, interpreted as evidence of congenital glaucoma.

The left half of the body was definitely smaller than the right—the left arm being 3 inches shorter than the right and the left leg 2 inches shorter than the right (Fig. 2). Neurological examination revealed complete spastic paralysis of the left arm and spastic paresis of the left leg. Deep reflexes were uniformly hyperactive on the left with sustained ankle clonus on the left. The Babinski sign was positive bilaterally. There was no disturbance of the sensory modalities.

Laboratory Findings. Entirely negative, including negative serological findings. Permission for lumbar puncture refused. Electrocardiogram showed diffuse myocardial damage, evidenced by diphasic to inverted T waves in standard and precordial leads.

Roentgen Examination. Routine views of the skull showed a diffuse intracranial calcific density on the right outlining the convolutions of the cerebral cortex of the occipital and to a lesser degree the parietal lobes, the density being greatest posteriorly and fading out an-

* From the Departments of Medicine and Roentgenology, Wayne University College of Medicine and City of Detroit Receiving Hospital, Detroit, Michigan.

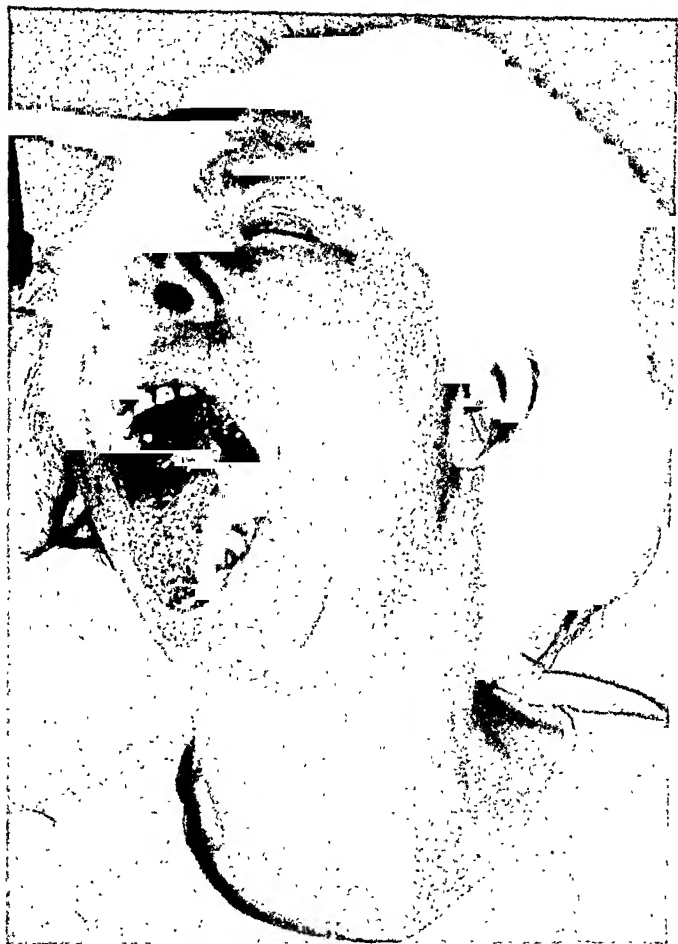


FIG. 1. Photograph showing right-sided distribution of facial nevus, limited chiefly to the area supplied by the ophthalmic and maxillary division of the trigeminal nerve.

teriorly as the central sulcus of Rolando was approached. The calcified cortex was separated from the inner table of the vault by a space of 1.5 cm., indicating cerebral atrophy (Fig. 3). Examination of the extremities showed obvious difference in size of the hands and of the feet, the left hand and foot being the smaller. The bones were well formed and exhibited normal architecture and density. Permission for cerebral pneumography and angiography was refused.

DISCUSSION

The foregoing case exhibited most of the classical features of the Sturge-Weber syndrome. In almost every case the facial nevus—a vascular nevus or “port-wine stain”—conformed to the area supplied by one or more main divisions of the trigeminal nerve, most often the ophthalmic. Symptoms usually began in infancy or early childhood with convulsions, either generalized or localized to the side contralateral to the facial nevus. These were

described in about 80 per cent of the recorded cases. Mental retardation of varying degree was noted in about 60 per cent of cases. Paresis, almost always in the form of a spastic hemiplegia or hemiparesis on the side contralateral to the facial hemangioma, was also present in more than half



FIG. 2. Photograph demonstrating the hypotrophy of the extremities on the left.

the cases. Unilateral underdevelopment of the paretic side of the body may be noted as body growth progresses.

Various ocular abnormalities, among them buphthalmos, unilateral exophthalmos, ocular palsies, irregular pupils, optic atrophy, hemianopsia, and nystagmus, were described in over 30 per cent of cases. Rarer associated findings include speech defects and obesity.⁴

findings of the Sturge-Weber syndrome.⁹

The type of calcification noted in our case and in many of the most typical cases of this syndrome reported, however, consisted of a more diffuse calcific density outlining the contours of a portion of or the entire cortex of one cerebral hemisphere. The convolutional pattern was clearly defined in these cases. In all instances the involved portion of cerebrum appeared

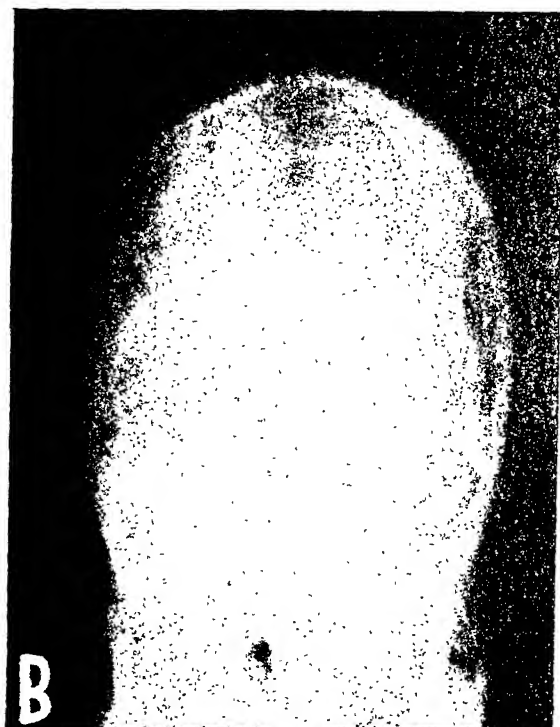


FIG. 3. (A) Right lateral roentgenogram of the skull of the same patient, showing calcification outlining the cerebral cortex. Separation of the calcified cortex from the inner table of the vault indicating cerebral atrophy is clearly shown. (B) Anteroposterior roentgenogram of same case showing limitation of the involvement to the right cerebral hemisphere. The characteristic convolutional pattern is again clearly seen.

The roentgenographic findings in Sturge-Weber syndrome are of primary importance since almost 90 per cent of the reported cases in which roentgenographic studies of the skull were obtained showed evidence of intracranial calcification.⁴ Many of the cases exhibited the type of calcification known to be associated frequently with angiomata of the meninges—namely, sinuous, parallel linear streaks of calcification and, frequently, ring shadows apparently representing vessels seen end-on. This type of calcification is, of course, often seen in angiomata without the usual

atrophic. In almost every case the involvement was posterior to the sylvian fissure and the central sulcus.

The basis for this unusual type of intracranial calcification is explained by the few cases of typical Sturge-Weber syndrome seen at necropsy or at craniotomy. In 1934 Krabbe⁷ first correlated the roentgenographic findings with the neuropathology. He reported one case with diffuse intracranial calcification of the type described above which, at necropsy, showed only slight angiomatous formation of the pia anterior to the calcification seen on skull

roentgenograms, but corresponding exactly to the site of roentgenographic findings, there was marked deposition of fine granules of calcific material in the second and third layers of the cerebral cortex. This area showed definite cortical atrophy. Almost identical pathologic findings were reported by Stewart¹⁰ in 1931 in a typical case of this syndrome, but no evidence of intracranial angiomas was found. Unfortunately, no roentgen studies were obtained in this case.

Actual angiomas of the meninges have been found at operation and at necropsy in some cases of this disease, but these cases usually have not shown typical diffuse calcification outlining the cerebral cortex. Green³ reported a case in which sinuous, double-contoured calcification following the cerebral convolutions in the anterior parietal area were noted on the skull roentgenogram. A specimen obtained from this area by craniotomy revealed the presence of actual angiomas of the dura and pia arachnoid. There were some calcific aggregates in the leptomeninges as well as similar deposits in the outer laminae of the underlying cortex. In a few other cases^{2,4,6,13} pathological reports cited the presence of angiomas or at least increased vascularity of the meninges in this condition, but no mention was made of the presence of calcification, either in the brain or its coverings.

Pneumoencephalography has been described in very few of the reported cases. Brock and Dyke¹ reported a case in which the air encephalogram confirmed the presence of cortical atrophy demonstrated by the diffuse cortical calcification. Definite internal hydrocephalus was also noted. In Green's case³ the pneumoencephalogram revealed marked cortical atrophy of the involved hemisphere and dilatation of the corresponding lateral ventricle.

Cerebral angiography has also been reported in very few cases. In 1935 Egas Moniz and Almeida Lima⁸ reported a typical case of Sturge-Weber disease in which

they could demonstrate no association between the intracranial calcification outlining the surface of the occipital lobe and any of the vessels visualized on either the arterial or venous phase of cerebral angiography. Green,³ however, in angiographic studies on his case, described involvement of the meningeal vessels in the region of the intracranial calcification.

Insufficient material on roentgenographic findings of pneumoencephalography and angiography in this condition is available to warrant a definite statement as to the findings to be expected. From a diagnostic standpoint, however, the routine skull roentgenograms showing intracranial calcification diffusely outlining the cerebral cortex, especially posteriorly, is considered to be pathognomonic, since we have been unable to find this type of calcification described as occurring in any other condition. Cerebral atrophy in the affected area can usually be made out without the use of contrast studies if the type of calcification just described is present.

An interesting phase of this subject is the apparently close association of encephalotrigeminal angiomatosis with certain other conditions which together have been grouped under the term "neurocutaneous syndromes." This group includes tuberous sclerosis, neurofibromatosis, and neuro-ocular angiomatosis (von Hippel-Lindau's disease) in addition to Sturge-Weber's disease. A common embryological background for these conditions has been postulated by Yakovlev and Guthrie.¹⁴ These four syndromes bear some resemblance to one another in clinical picture and may exhibit some features in common. Intracranial calcification may occur in any of the neurocutaneous syndromes, but calcification conforming to the cerebral convolitional pattern is typical of encephalotrigeminal angiomatosis. The roentgenologic findings in these conditions have been described by Heublein, Pendergrass and Widmann,⁵ and further discussion is beyond the scope of this presentation.

SUMMARY

1. A case of unusual intracranial calcification seen in association with ipsilateral facial nevus, contralateral spastic hemiplegia, and mental deficiency is presented.

2. The clinical, roentgenographic, and pathological findings in encephalotrigeminal angiomatosis are described. Two main types of intracranial calcification are seen in this condition—one type conforming to that seen in the meningeal angiomata, the other, probably characteristic of this syndrome, clearly outlining the convolutions of the cerebral cortex. The latter type is apparently produced by calcific deposits in the outer layers of the cerebral cortex.

3. The association of this condition with others of the neurocutaneous syndromes is discussed briefly.

Department of Radiology
Receiving Hospital
Detroit 26, Michigan

REFERENCES

1. BROCK, S., and DYKE, C. G. Venous and arterio-venous angiomas of the brain. *Bull. Neurol. Inst. New York*, 1932, 2, 247-293.
2. CUSHING, H. Cases of spontaneous intracranial hemorrhage associated with trigeminal nevi. *J.A.M.A.*, 1906, 47, 178-183.
3. GREEN, J. R. Encephalo-trigeminal angiomatosis. *J. Neuropath. & Exper. Neurol.*, 1945, 4, 27-42.
4. GREENWALD, H. M., and KOOTA, J. Associated facial and intracranial hemangiomas. *Am. J. Dis. Child.*, 1936, 51, 868-896.
5. HEUBLEIN, G. W., PENDERGRASS, E. P., and WIDMANN, B. P. Roentgenographic findings in the neurocutaneous syndromes. *Radiology*, 1940, 35, 701-727.
6. KALISCHER, S. Demonstration des Gehirns eines Kindes mit Telangiectasie der linkseitigen Gesichtskopfhaut und Hirnoberfläche. *Berl. klin. Wchnschr.*, 1897, 34, 1059.
7. KRABBE, K. H. Facial and meningeal angiomatosis associated with calcifications of the brain cortex. *Arch. Neurol. & Psychiat.*, 1934, 32, 737-755.
8. EGAS MONIZ, E., and ALMEIDA LIMA. Pseudo-angiomes calcifiés du cerveau. Angiome de la face et calcifications corticales du cerveau (maladie de Knud H. Krabbe). *Rev. neurol.*, 1935, 63, 743-750.
9. SCHWARTZ, C. W. Vascular tumors and anomalies of the skull and brain from a roentgenologic viewpoint. *Am. J. Roentgenol. & Rad. Therapy*, 1939, 41, 881-900.
10. STEWART, R. M. A case of infantile hemiplegia associated with facial nevus and mental defect. *J. Neurol. & Psychopath.*, 1931, 12, 47.
11. STURGE, A. A case of partial epilepsy, apparently due to a lesion of one of the vasomotor centers of the brain. *Tr. Clin. Soc., London*, 1879, 12, 162.
12. WEBER, F. PARKES. Right-sided hemihypotrophy with a morbid condition of the left side of the brain, revealed by radiograms. *J. Neurol. & Psychopath.*, 1922, 3, 134.
13. WEBER, F. PARKES. A note on the association of extensive hemangiomatic nevus of the skin with cerebral (meningeal) hemangioma, especially cases of facial vascular nevus with contralateral hemiplegia. *Proc. Roy. Soc. Med.*, 1928, 22, 431-422.
14. YAKOVLEV, P. I., and GUTHRIE, R. H. Congenital ectodermoses (neurocutaneous syndromes) in epileptic patients. *Arch. Neurol. & Psychiat.*, 1931, 26, 1145-1194.



BIOLOGICAL EFFECTS OF ROENTGEN RAYS OF VARIOUS WAVELENGTHS

By V. V. BRUNST* and E. A. SHEROMETIEVA-BRUNST

New York Aquarium, New York Zoological Society

NEW YORK, NEW YORK

IN order to compare the biological effects of different kinds of roentgen rays two series of experiments were performed. In the first series unfiltered, low voltage roentgen rays (soft roentgen rays), in the second series filtered, high voltage roentgen rays (hard roentgen rays) were used (Table I).

TABLE I

Kind of Roentgen Rays	kv. max.	ma.	Filter	Distance between Target and Object
Soft	43	3	—	17 cm.
Hard	140	3	3 mm. Al	17 cm.

Five hundred and ten adult tritons (*Triton cristatus*; Amphibia-Urodela) served as experimental animals. Their tails were treated locally with equal doses of both kinds of roentgen rays. Doses from 500 r to 10,000 r were administered in both series. The localization of treatment was accomplished with the apparatus shown in Figure 1 which consists of a wooden board (A) with sectors and a central disk (B) for restraining the animals, and a leaden collapsible cover (C) with openings in the central wall for triton tails. The bodies of

10 animals, bound with cheese cloth strips to the board, were protected with radiopaque cover while their tails, with the exception of 1 cm. of the proximal portion, were irradiated from the dorsal side. Approximately two months after the treatment the tails of all animals were amputated. Stumps, 2 cm. long, were left; thus the plane of the amputation passed through the treated region. The process of regeneration as well as some other phenomena would serve to characterize the degree of the biological effects of soft and hard roentgen rays.

The results of both series of experiments are given in Table II. The difference between them is rather insignificant. Thus from these experiments it appears that both soft and hard roentgen rays produce the same biological effect as concerns the mortality of animals, occurrence of necrosis, failure or presence of tail regeneration and the mean length of the regenerates. In both series the heaviest injuries, such as death, necrosis, and failure of the tail to regenerate were caused by large doses; tail regeneration occurred after the treatment with small doses and the length of the regenerates regularly decreased with the increase in dosage.

TABLE II

Kind of Roentgen Rays	Number of Animals in Series	Percentage of Animals Which Died during Experiment	Percentage of Animals Which Had Necrosis	Regeneration		
				Percentage of Animals without Tail Regeneration	Percentage of Animals with Tail Regeneration	Mean Length of Tail Regenerates in mm.
Soft	250	49.5	36.4	62.0	38.0	4.95
Hard	260	41.5	39.0	63.5	36.5	4.23

* Senior fellow, National Institute of Health, United States Public Health Service.

These results agree with those of many other authors, e.g., Wood,³⁶ Packard,^{25,26,27} Piepenborn,²⁹ Vierheller and Saralegui,³³ Hoffmann,¹⁴ Langendorff, Langendorff and Reuss,¹⁹ Obreschkove,²⁴ Dahl,⁶ Marshak,²² del Buono,⁴ Bade,¹ Fabergé,¹⁰ Lasnitzki and Lea,²⁰ Lingley, Gall and Hilcken,²¹ Pascher and Kanee,²⁸ and others.

experiments analyzed in this paper have to be described once more. If the results of the treatment with both kinds of roentgen rays are considered from the standpoint of all features used above no significant difference can be noticed. But if another sign is taken as characteristic in the evaluation of soft and hard roentgen-ray effects,

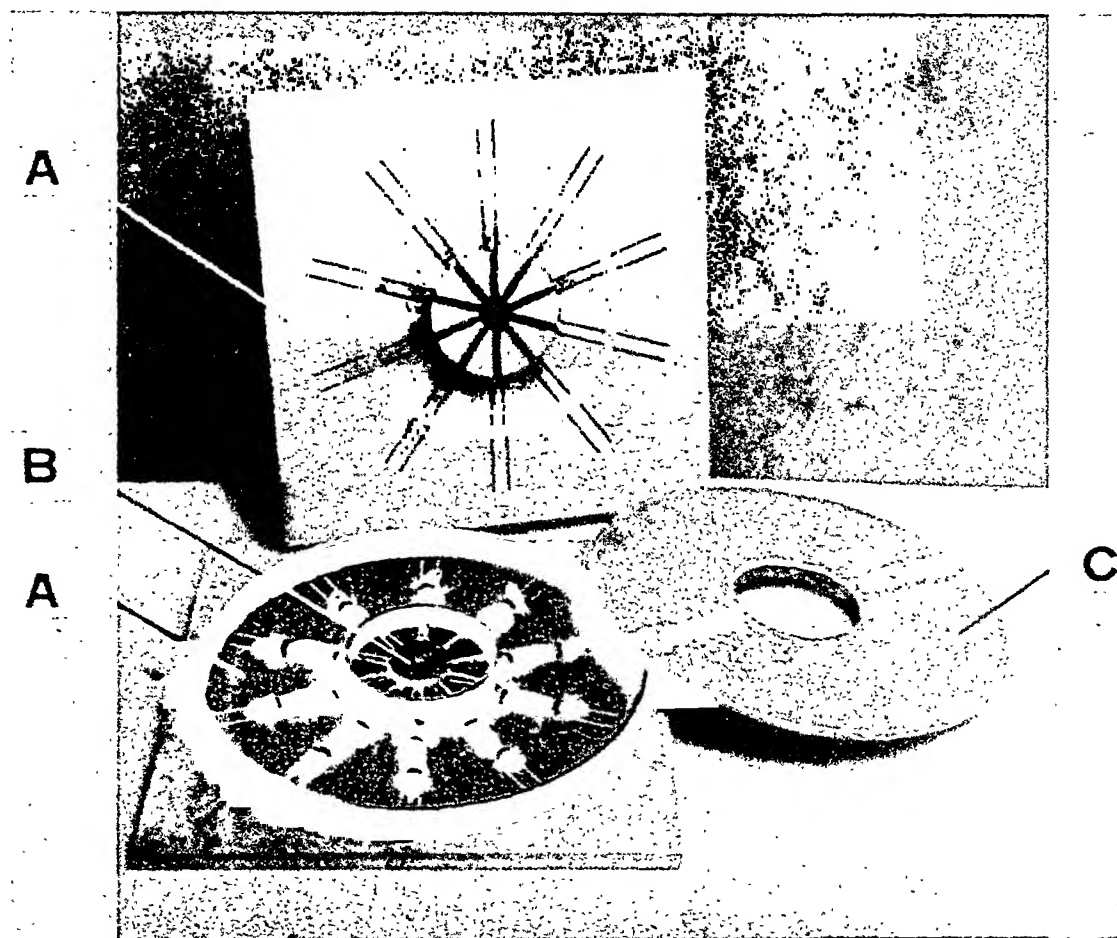


FIG. 1. The apparatus for local irradiation of triton tails.

But there is another opinion according to which these two kinds of roentgen rays produce different results, e.g., Rost,³¹ Holthusen,¹⁵ Martius,²³ Wintz and Rump,³⁵ Lachmann and Stubbe,¹⁸ Ingber,¹⁶ Dognon,^{8,9} Henshaw and Francis,¹³ Goldfeder,¹¹ Haberman and Ellsworth,¹² den Hoed and Stoel,⁷ Juris,¹⁷ Roffo,³⁰ Weiss,³⁴ and others.

When comparing the effects of soft and hard irradiation, the kind of treated material, its size, and the method of interpreting the effects have to be taken into consideration. In order to explain this statement the

namely the morphological structure of regenerates, other conclusions ought to be drawn.

In tritons the normal tail regenerate is a symmetrical organ divided by the axial skeleton into equal dorsal and ventral parts. This symmetry is conserved even in cases where the plane of the amputation is not perpendicular to the long axis of the tail (Barfurth²). The regenerates of the animals treated with hard roentgen rays had symmetrical structures in 93 per cent of the total number of cases. As to the

regenerates of the animals treated with soft roentgen rays only 41 per cent of them were symmetrical while 59 per cent were asymmetrical. Twenty-eight per cent of regenerates had a strongly expressed upward curvature of the growth axis (Fig. 2).

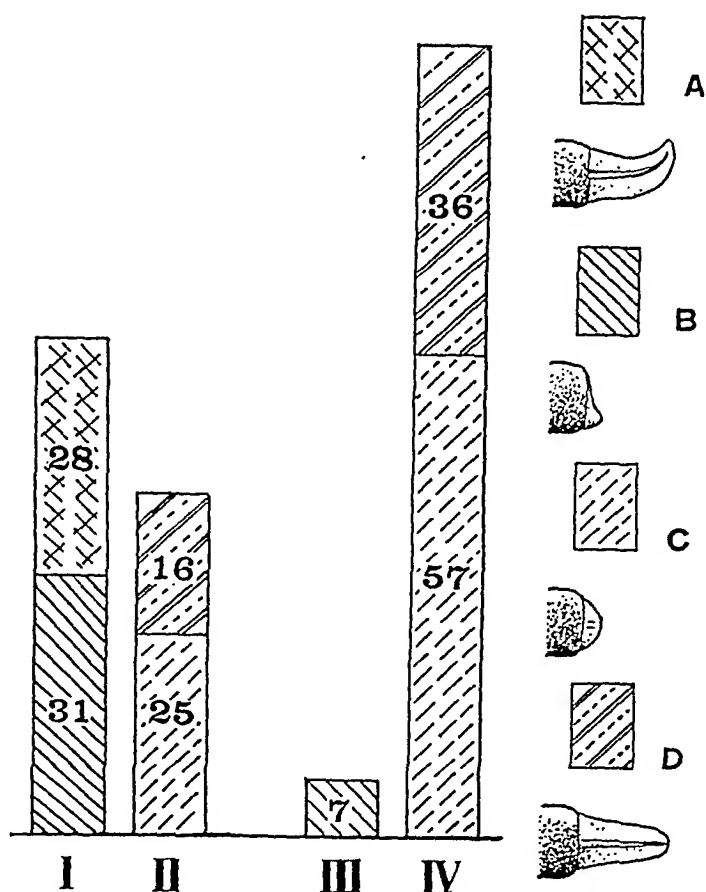


FIG. 2. The comparison of effects of soft (columns I and II), and hard (columns III and IV) roentgen rays on the morphological structure of tail regenerates.

A, large regenerates with clearly expressed curvature.

B, small regenerates with asymmetrical structure.

C, small regenerates with symmetrical structure.

D, large regenerates with symmetrical structure.

In *Triton cristatus* this phenomenon had been observed and described by Brunst and Chérémétieva.³ Similar asymmetrical forms were observed for the first time in tail regenerates of tadpoles of *Pelobates fuscus* treated with soft roentgen rays (Scheremetjewa and Brunst³²). At that time a question arose as to why the asymmetry was invariably the same; the axial part of the regenerates was always turned upward instead of being directed horizontally. The theoretical suggestions that

this curvature was caused by the direction of the roentgen rays was demonstrated by experiments in which the irradiation with the same kind and dose of roentgen rays was applied not from the dorsal but from the ventral side. All curvatures were directed downwards (Chérémétieva and Brunst⁵).

The beam of unfiltered roentgen rays used in the "soft series" contained various kinds of soft rays. According to Wucherpennig³⁷ such a beam of roentgen rays passing through the water gradually loses a considerable part of the "softest" rays. This is due to the absorption of these "softest" rays by the water. The originally applied dose decreases in proportion to increase in the depth of the water (Table III).

TABLE III

Depth in mm.	Percentage of the Dose
I	100
2	90
3	80
4	70
5	60
6	50
7-8	40
9-10	30

All living tissues possess almost the same absorption ability. They act like a filter. Therefore the part of the treated organ situated closest to the roentgen tube gets the dosage indicated, while other parts approaching the opposite side receive a greatly decreased dosage. This gradual decrease in dosage corresponding to the depth, resulted in the unequal inhibition of the regenerative capacity in different parts of the organ. This undoubtedly caused the formation of asymmetrical regenerates. Such is the case with soft roentgen rays. The hard roentgen rays used in the experiments were homogeneous, as they were filtered. They passed through the whole thickness of the tissues almost without suffering any loss through absorp-

tion and no obvious differences could be noticed between the acting doses at the opposite sides of the tails 10 to 12 mm. high. That was why only 7 per cent of regenerating tails were inhibited asymmetrically (Fig. 2).

SUMMARY

These experiments show that some biological effects of the soft and hard roentgen rays are apparently identical, e.g. the mortality of treated animals, frequency of necrosis, absence and presence of tail regeneration and the mean length of regenerates. But as regards the structure of the regenerates, there is a great difference between effects of soft and hard roentgen rays as a result of the absorption of soft rays by tissues. The last becomes especially evident if the irradiated object has a considerable thickness.

We wish to express appreciation to Mr. Donn Eric Rosen for help in the preparation of the manuscript.

Dr. V. V. Brunst
Department of Anatomy
University of Maryland
School of Medicine
Baltimore 1, Md.

REFERENCES

1. BADE, H. Röntgenstrahlenqualität und Hautreaktion. *Strahlentherapie*, 1940, 68, 53-62.
2. BARFURTH, D. Versuche zur funktionellen Anpassung. *Arch. mikr. Anat.*, 1891, 37.
3. BRUNST, V., and CHÉRÉMÉTIEVA, E. Recherches sur l'influence des rayons X sur la régénération de la queue du Triton après une seule irradiation à doses variées. *Arch. de biol.*, Paris, 1935, 46, 357-368.
4. DEL BUONO, P. Ueber einige ungelöste Probleme der Strahlenbiologie. *Strahlentherapie*, 1939, 65, 108-120.
5. CHÉRÉMÉTIEVA, E., and BRUNST, V. Influence des rayons X sur la régénération de la queue des têtards. Curbure causée par les rayons X sur les queues régénérées. *Compt. rend. Soc. de biol.*, 1935, 119, 189-190.
6. DAHL, B. de l'effet des rayons X sur les os longs en développement et sur la formation de cal. Etude radiobiologique et anatomique chez le rat. Jacob Dybwad, Oslo, 1936.
7. DEN HOED, D., and STOEL, G. The "supervoltage" roentgen installation in the Antoni van Leeuwenhoekhuis at Amsterdam. 3. Action of ultra-hard roentgen rays on *Drosophila* eggs. *Acta radiol.*, 1940, 21, 591-596.
8. DOGNOX, A. Le mesure et l'action biologique des rayons X de différentes longueurs d'onde. *Arch. phys. biol.*, 1925, 4, 87-182.
9. DOGNOX, A. Action des rayons X monochromatique de longueur d'onde différente sur l'oeuf d'*Ascaris*. *Compt. rend. Acad. de sc.*, 1933, 196, 437-438.
10. FABERGÉ, A. C. The equivalent effect of x-rays of different wave length on the chromosomes of *Tradescantia*. *J. Genet.*, 1940, 379-384.
11. GOLDFEDER, A. Further studies on effect of irradiation on proliferation and metabolic processes of normal and malignant tissues. *Radiology*, 1940, 35, 210-228.
12. HABERMAN, S., and ELLSWORTH, L. D. Lethal and dissociative effects of x-rays on bacteria. *J. Bact.*, 1940, 40, 483-503.
13. HENSHAW, P. S., and FRANCIS, D. S. Further studies with seedlings on the question of wavelength dependence of radiobiological reactions. *Am. J. Cancer*, 1939, 35, 386-400.
14. HOFFMANN, C. Strahlenhärte und biologische Wirkung. *Strahlentherapie*, 1932, 43, 140-159.
15. HOLTHUSEN, H. Ueber die biologische Wirksamkeit der Röntgenstrahlen verschiedener Wellenlänge. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1919-1921, 27, 213-244.
16. INGBER, E. Zur tema dell'azione biologica dei raggi Röntgen duri, semimolli e molli. Ricerche eseguite sulla *Vicia faba* var. minor. *Atti ist. bot. ecc. Pavia*, 1932, 4, 9-13.
17. JURIS, K. Vergleichenden Untersuchungen der Röntgenstrahlung einer 500 k.v. Apparatur und einer 200 k.v. Apparatur. Physikalische Experimente über die Wirkung der zwei Strahlenqualitäten auf das Knochengewebe. *Radiol. clin.*, 1941, 10, 205-222.
18. LACHMANN, E., and STUBBE, H. Ueber die biologische Wirkung der Grenzstrahlen verglichen mit harten Röntgenstrahlen. *Strahlentherapie*, 1932, 43, 489-516.
19. LANGENDORFF, H., LANGENDORFF, M., and REUSS, A. Ueber die Wirkung von Röntgenstrahlen verschiedener Wellenlänge auf biologische Objekte. *Strahlentherapie*, 1933, 46, 655-662.
20. LASNITZKI, I., and LEA, D. E. Variation with wavelength of the biological effect of radiation. *Brit. J. Radiol.*, 1940, 13, 149-161.
21. LINGLEY, J. R., GALL, E. A., and HILCKEN, J. A. Comparative experimental studies of 200 kilovolt and 1000 kilovolt roentgen rays. II. Biological effects on the bone marrow of the albino rat. *Am. J. Path.*, 1940, 16, 845-854.
22. MARSHAK, A. Effect of x-rays on chromosomes in mitosis. *Proc. Nat. Acad. Sc.*, 1937, 23, 362-369.

23. MARTIUS. Die biologische Wirkung der Röntgenstrahlen verschiedener Wellenlänge. *Strahlentherapie*, 1922, 14, 558-560.
24. OBRESCHKOVE, V. Quantitative biological effect of x-rays of different effective wave lengths. *Physiol. Zoöl.*, 1934, 7, 330-339.
25. PACKARD, C. Quantitative biological effects of x-rays of different wave lengths. *J. Cancer Research*, 1927, 11, 1-15.
26. PACKARD, C. Relation of wave length to death rate of *Drosophila* eggs. *J. Cancer Research*, 1929, 13, 87-96.
27. PACKARD, C. Biological effectiveness of high-voltage and low-voltage x-rays. *Am. J. Cancer*, 1932, 16, 1257-1274.
28. PASCHER, F., and KANEE, B. Reactions of hemopoietic system to agents used in the treatment of dermatoses. Effects of low voltage roentgen ray therapy. *Arch. Dermat. & Syph.*, 1946, 53, 1-5.
29. PIEPENBORN, J. Versuche über dem Wirkungsgrad von Röntgenstrahlen verschiedener Wellenlänge auf die Milz der Maus, bei gleicher Dosis, gemessen in R-Einheiten. *Strahlentherapie*, 1929, 33, 322-337.
30. ROFFO, A. E., JR. Acción de las radiaciones ultrapenetrantes (400-600 k.V.) sobre las células animales cultivadas in vitro. *Bol. Inst. de med. exper. para el estud. trat. d. cáncer*, 1942, 19, 531-528.
31. ROST, G. A. Experimentelle Untersuchungen über die biologische Wirkung von Röntgenstrahlen verschiedener Qualitäten. *Strahlentherapie*, 1915, 6, 269-329.
32. SCHEREMETJEW, E. A., and BRUNST, V. V. Untersuchung des Einflusses von Röntgenstrahlen auf die Regeneration des Schwanzes bei den Kaulquappen von *Pelobates fuscus*. *Arch. f. Entwicklungsmech. d. Organ.*, 1933, 130, 771-791.
33. VIERHELLER, F., and SARALEGUI, J. A. Röntgenwellenlänge und biologischer Effekt. *Strahlentherapie*, 1930, 38, 641-654.
34. WEISS, J. Biological action of radiation. *Nature*, 1946, 157, 584.
35. WINTZ, H., and RUMP, W. Biologische Wirkung verschiedener Röntgenstrahlenqualitäten. *Strahlentherapie*, 1926, 22, 451-459.
36. WOOD, F. C. Further studies in the effectiveness of different wave lengths of radiation. *Radiology*, 1925, 5, 199-205.
37. WUCHERPFENNIG, V. Zur Verteilung der Röntgenstrahlen in der Haut. *Strahlentherapie*, 1931, 42, 544-550.



DEPTH DOSE DATA AND ISODOSE DISTRIBUTIONS FOR RADIATION FROM A 22 MEV. BETATRON

By H. E. JOHNS,* E. K. DARBY,† R. N. H. HASLAM‡, L. KATZ,‡ and E. L. HARRINGTON‡

Physics Department, University of Saskatchewan

SASKATOON, SASKATCHEWAN, CANADA

INTRODUCTION

IN THE last few years several papers^{1,2,4} have been published on the possible uses of the high energy roentgen radiation from the betatron for medical therapy. Before such radiation can be used effectively for this work, problems involving stray radiation, the collimation of the beam, the production of fields of a variety of different sizes and the construction of a betatron which is flexible with respect to its position and orientation of beam must be solved. Recently the betatron group of the University of Illinois¹ has published information on the first two problems stated above. The authors are indebted to them for many of the ideas discussed in this paper. The authors have produced fields of radiation of different sizes and have found how the depth dose depends on area and focal skin distance. The problem of flexibility of the betatron beam still remains to be solved. By using the information which has been obtained by Quastler and Clark⁵ on the biological effectiveness of betatron radiation it should be possible to employ the betatron for roentgen therapy.

EXPERIMENTAL ARRANGEMENT FOR DEPTH DOSE MEASUREMENTS

Part of the apparatus used for the measurement of the distribution of radiation within a scattering medium is shown in Figure 1. The phantom consisted of a tank of water as illustrated. Radiation from the betatron was introduced into this tank of water through an aluminum window 0.4 mm. thick. The ionization chamber was connected to a pre-amplifier as indicated and arranged so that it could be moved in

a controlled and known way in three directions mutually at right angles. This was done very conveniently from the control room by means of two pairs of selsyn generators and motors. The selsyn motors were used to drive screws of 1 mm. pitch. In the diagram of Figure 1 these are shown directly connected to the screws, but in actual fact they were connected to the screws by means of a small chain and sprocket. The selsyn generators in the control room were turned by hand and the position indicated by means of a small counter above each selsyn. Since one turn of the selsyn generator corresponds to one turn of the selsyn motor, which in turn corresponds to a motion of 1 mm., the position indicators gave the position in millimeters. The third motion was obtained by means of a pinion and ratchet arrangement which is not shown in Figure 1. This arrangement has proved useful for making routine measurements of radiation in hospitals. Where a vertical roentgen-ray beam can be used the radiation is made to impinge on the surface of the water in the tank.

The ionization chamber and pre-amplifier were connected by a long flexible cable to a sensitive negative feedback D.C. amplifier. This amplifier was developed by some of the authors.³ The details of construction may be obtained from the original paper. To make measurements in this phantom it is necessary continually to monitor the roentgen-ray beam from the betatron. This can be done in several ways but one simple way which proved to be satisfactory was to place a large monitor ionization chamber as indicated in Figure 1.

* Professor of Physics and Physicist with the Saskatchewan Cancer Commission.

† Research Associate.

‡ Professor of Physics.

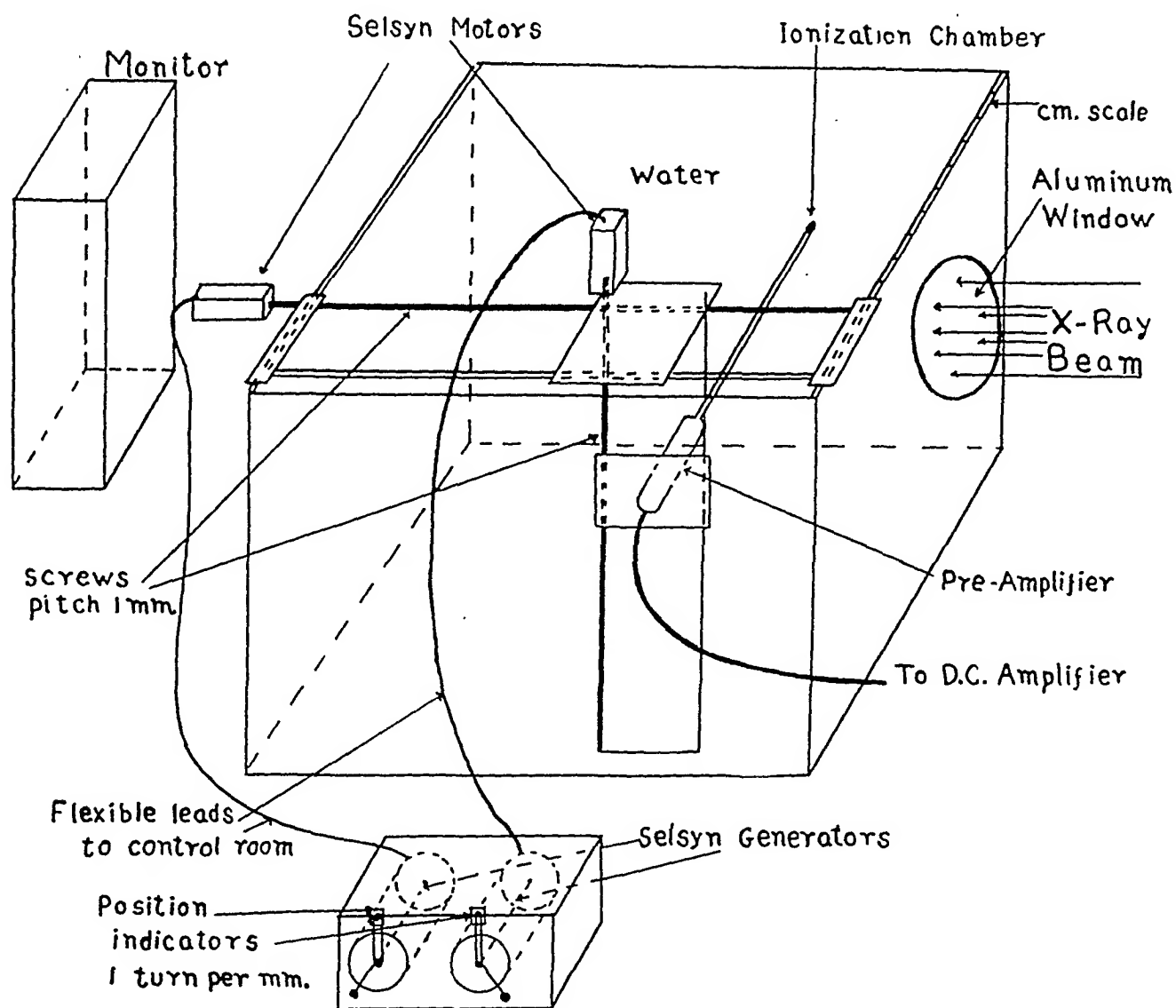


FIG. 1. Schematic diagram of water phantom showing the method for remote control of the position of the probe.

This chamber was provided with fifteen thin lead plates and was connected to the standard amplifier provided with the Allis-Chalmers betatron. This ionization chamber actually measured the amount of radiation which passed through the tank of

water. For all practical purposes, this will be independent of the position of the probe. The details of the thimble ionization chamber and its connection to the pre-amplifier are shown in Figure 2. The details of the pre-amplifier will be found in the

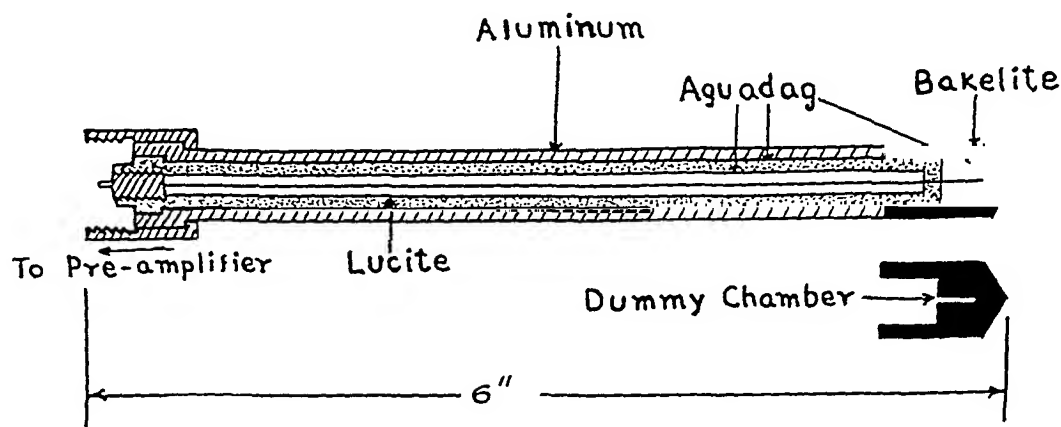


FIG. 2. Diagram showing the details of the probe.

original paper.³ Considerable difficulty was experienced in producing a connection between the pre-amplifier and the thimble chamber which was not sensitive to betatron radiation. To investigate this effect, a probe assembly was made using a dummy ionization chamber (see Fig. 2) and this assembly was placed in the betatron beam. It was found that a stem of very thin walls

tion under the action of the betatron radiation. To make sure that this neutralization was present during the experiments with the betatron, the following procedure was carried out. After a set of measurements had been made using a real ionization chamber on the end of the probe, the dummy cap was placed over the probe and the probe was placed in the position at

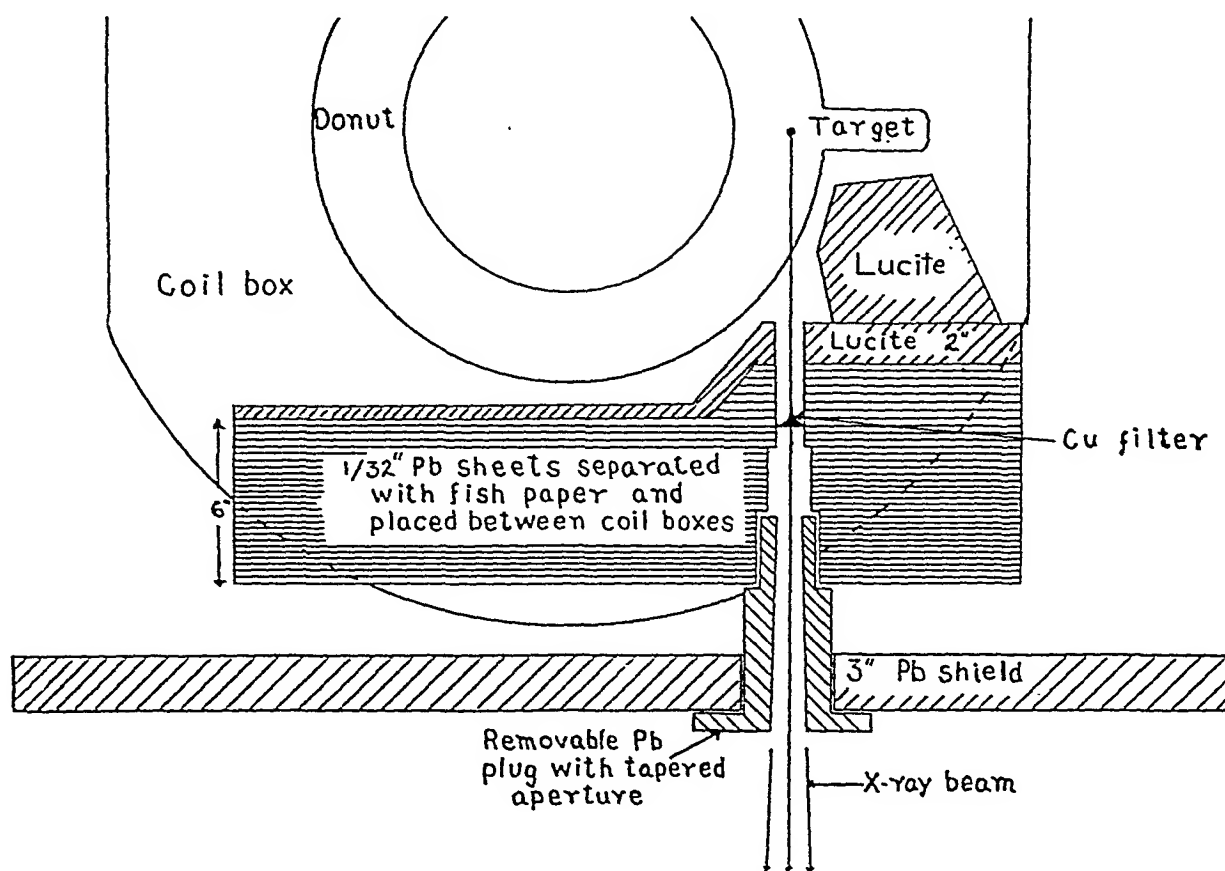


FIG. 3. Schematic top view of the betatron showing the collimating and shielding arrangements, etc.

gave a positive deflection on the amplifier. The polarity of the D.C. amplifier was such that a positive deflection corresponded to the collection of positive charges on the central electrode. As the thickness of the aluminum wall was increased, or a sleeve of aluminum was placed on the outside of the stem, the positive deflection was decreased and finally reversed to give a negative deflection. The authors are as yet unable to explain this phenomenon. However, by trial and error it was possible to construct a probe assembly with a dummy ionization chamber which gave practically no deflec-

which the original measurements had been made. In all cases it was found that the effect of the radiation on the stem was of the order of only 1/1000 to 1/5000 of the effect on the ionization chamber. The ionization chamber used had a volume of 200 cu. mm. If a smaller ionization chamber had been used the effect of the radiation on the stem would have been appreciable.

In making measurements the betatron was adjusted until a pre-selected intensity of radiation was indicated by the monitor and the reading of the D.C. amplifier was taken when the betatron gave this output.

Little difficulty was experienced in holding the betatron output constant at the pre-selected value enough to get a reading on the D.C. amplifier.

SHIELDING AND COLLIMATION PROCEDURE

The arrangement of the betatron and its associated shield is shown diagrammatically

3 inch lead shield was placed across the front of the betatron and a square hole was cut in it in line with the holes in the inner lead shield. It was found possible to insert through this lead shield and into the inner lead shield any one of a series of hollow lead plugs, one of which is shown in Figure 3. The holes in these plugs were circular in

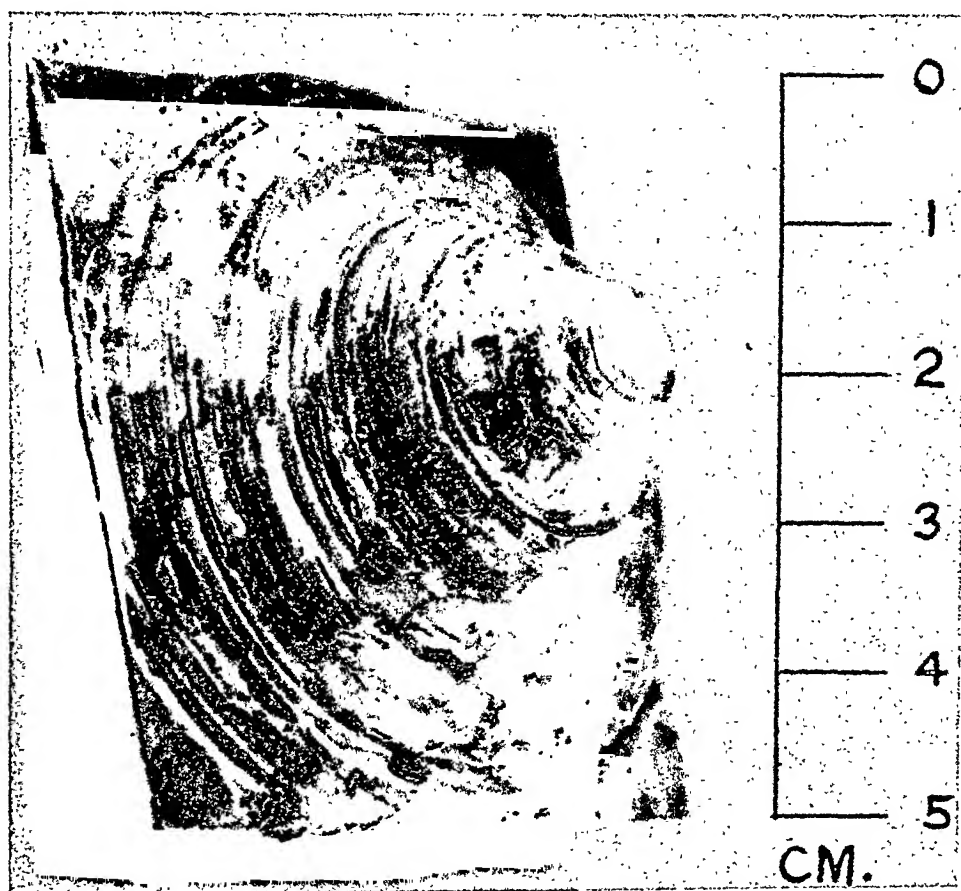


FIG. 4. Photograph of the copper compensating filter.

in Figure 3. Many of the features included in the shielding process are taken from the work of the Illinois group.¹ The main shield consisted of laminated sheets of lead separated with fish paper placed between the coil boxes of the betatron with the dimensions shown. Next to the donut was placed a layer of lucite which served to stop stray electrons without any appreciable production of roentgen radiation. The hole through the lead shield consisted of a series of square openings as indicated. After this shield was mounted it was found that there was considerable radiation escaping just above and below the shield. To reduce this radiation and other scattered radiation a

cross section and tapered to give fields of diameters 4, 6, 8 and 10 cm. respectively at a distance of 70 cm. from the focal spot. With such an arrangement it was found that radiation at all points in the betatron room was reduced to a satisfactory level. Such an arrangement offers many advantages for nuclear physics experiments since plugs with smaller tapered holes can be inserted at will to produce a very finely collimated roentgen-ray beam.

It is well known that the radiation from the betatron is projected primarily in the forward direction, and beyond small angles to this direction the radiation intensity falls off very rapidly. To achieve a useful

beam for therapeutic purposes a compensating filter was developed. The authors found that a copper filter was more easily constructed than one of carbon,¹ and gave results which were just as good. An analysis of the total absorption coefficient will show that copper has almost a constant absorption coefficient from 5 to 25 mev., so that the use of such a filter will not change the quality of the beam. The copper filter was placed far enough back in the shield to as-

seen that for a 10 cm. circular field, the 100 per cent isodose curve reaches to within 1 cm. of the edge of the beam.

RESULTS OF DEPTH DOSE MEASUREMENTS

Measurements of the depth dose were carried out for circular fields of diameter 4, 6, 8 and 10 cm. at 70 cm. focal skin distance and 6, 9, 12 and 15 cm. at 105 cm. focal skin distance. In all cases the doses were expressed as a percentage of the maximum

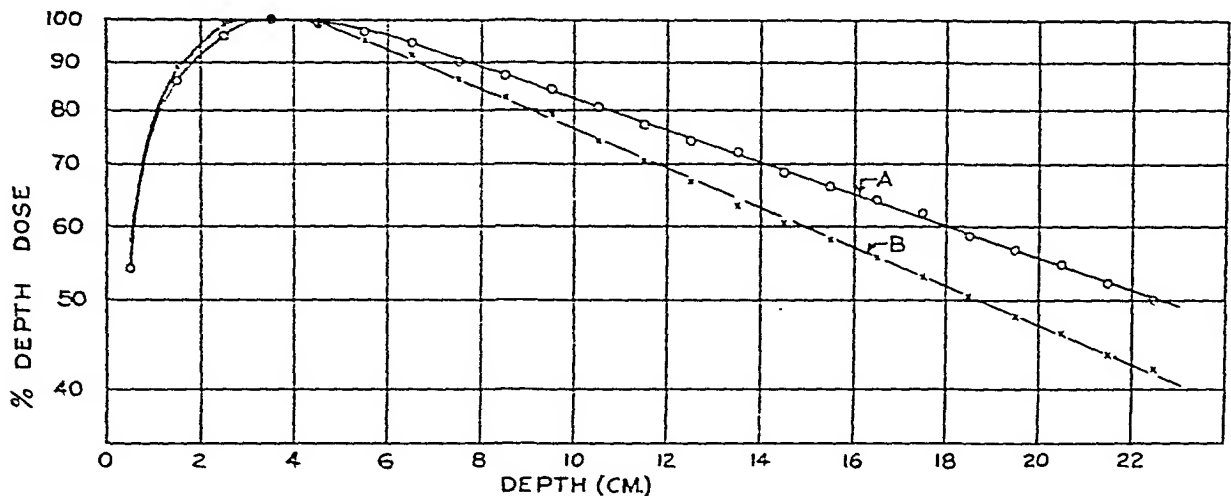


FIG. 5. Typical percentage depth dose graph: A—15 cm. circular field at 105 cm. F.S.D.; B—10 cm. circular field at 70 cm. F.S.D. using radiation from a 22 mev. betatron with a copper compensating filter.

sure that the fringing field of the betatron would divert from the beam the electrons ejected from the filter. A photograph of the copper filter is shown in Figure 4. It was found necessary to make the filter somewhat asymmetrical due to the nature of the beam of radiation from our betatron. The shape of the copper filter was determined by trial and error, using the D.C. amplifier and ionization chamber for checking the variation of the intensity over a cross section of the beam and photographic films for the detection of sudden changes in intensity. By this process it was possible to obtain the distribution of radiation shown in Figure 12. The authors feel that this distribution is very satisfactory from the point of view of therapy. In fact, the falling off of the beam as one proceeds laterally from the axis of radiation is less pronounced than is the case with a low voltage roentgen-ray distribution. It will be

dose. Typical results for two fields are shown in Figure 5 and a summary of all the results are given in Table 1. It will be seen that the maximum dose occurs 4 cm. from the surface and that the percentage depth dose rises rapidly from a small value at the surface to this maximum and then falls off much more slowly. It will be seen that the variation from the average curve does not exceed 1 per cent. Due to the thickness of the aluminum window in the phantom and the finite size of the ionization chamber, measurements could not be made with the center of the ionization chamber closer than 0.5 cm. to the surface. Theory indicates that the percentage depth dose at the surface should be zero, while extrapolation of the graphs in Figure 5 to zero depth indicates that the percentage depth dose at the surface is certainly less than 30 per cent. From Table 1 it will be seen that for small depths some variation in

dose occurs from one size field to another. This is due to the difficulty of making accurate measurements in this region where the depth dose changes rapidly with depth. From Table I it is apparent that for a given focal skin distance the percentage depth dose along the axis is independent of

forward direction by the action of the high energy photons. The actual percentage depth doses herein reported are considerably greater than those obtained by Charlton and Breed² who obtained maximum ionization for 20 mev. radiation at a depth of 1.5 cm. but are in essential agreement

TABLE I

DEPTH DOSE DATA FOR 22 MEV. ROENTGEN RAYS AT 70 AND 105 CM. FOCAL SKIN DISTANCE USING A COMPENSATING COPPER FILTER IN THE ROENTGEN-RAY BEAM

Depth (x)	F.S.D.—70 cm.					F.S.D.—105 cm.					Universal Depth Dose $A=P_f\left[\frac{f+x}{f+4}\right]^2$
	Diameter of circular field				Average Value P_{70}	Diameter of circular field				Average Value P_{105}	
	4 cm.	6 cm.	8 cm.	10 cm.		6 cm.	9 cm.	12 cm.	15 cm.		
0.5	50	50	51	53	51	48	48	50	53	49.5	46
1	72	70	70	72	71	68	70	70	74	70	66
2	94	92	92	94	93	88	90	90	91	90	87.5
3	99.5	99	99	99.5	99	98	98	98	98	98	96.5
4	100	100	100	100	100	100	100	100	100	100	100
5	98.5	98	98.5	98	98.5	99.5	99.5	99.5	99	99.5	100
6	94	93.5	94	93	93.5	97	96	97	96.5	96.5	99
7	89.5	89	89.5	88.5	89	93	92.5	93	92.5	93	97
8	85	84.5	85	84.5	85	89	88.5	89.5	89	89	95
9	81	80.5	81	80.5	81	86	85.5	86	86	86	93
10	77	77	77	76.5	77	82.5	82	83	82.5	82.5	91
11	73.5	73	73.5	73	73.5	79	78.5	79.5	79	79	88.5
12	70	70	70	70	70	76	75.5	76.5	76	76	86.5
13	66.5	66.5	66.5	66.5	66.5	73	73	73.5	73	73	84.5
14	63.5	63.5	63.5	63.5	63.5	70	70	70.5	70	70	82.5
15	60.5	60.5	60.5	60.5	60.5	67	67	68	67.5	67.5	80.5
16	57.5	57.5	57	57	57.5	64.5	64.5	65	64.5	64.5	78.5
17	55	55	54.5	54.5	55	62	62	63	62.5	62.5	76.5
18	52	52	52	52	52	59.5	59.5	60.5	60	60	75
19	49.5	49.5	49.5	49.5	49.5	57	57	58	57.5	57.5	73
20	47.5	47.5	47	47	47.5	54.5	55	55.5	55	55	71.5
21	45	45	44.5	44.5	45	52	52.5	53.5	53	53	69.5
22	43	43	42.5	42.5	43	50	50.5	51.5	51	51	68

the area of the field. This is in sharp contrast with the variations observed with standard therapy radiations. For this reason the average percentage depth doses (P_{70} and P_{105}) for each depth studied were calculated and are recorded in Table I for both focal skin distances. These average depth doses have been plotted and appear in Figure 6. That the percentage depth dose is independent of area is due to the fact that electrons are projected in the

with those obtained by the Illinois group.¹ Because the depth dose is independent of area the authors have made an effort to analyze the curves shown in Figure 6 to see how these depend on focal skin distance and depth. An analytical expression which fits the data reasonably well can be obtained as follows. Let I_0 represent the flux density of the incident photons at the surface of the phantom (see Fig. 7). At a depth z below the

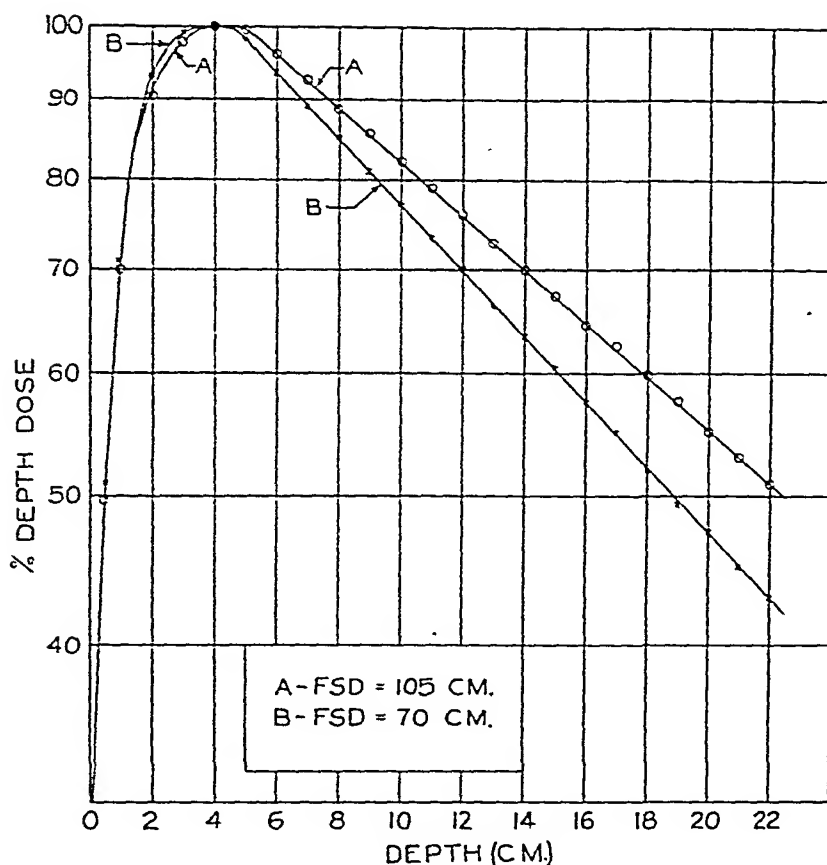


FIG. 6. Average percentage depth dose graphs for focal skin distances of 70 and 105 cm. using radiation from a 22 mev. betatron with a copper compensating filter. The points shown are the average values recorded in Table 1.

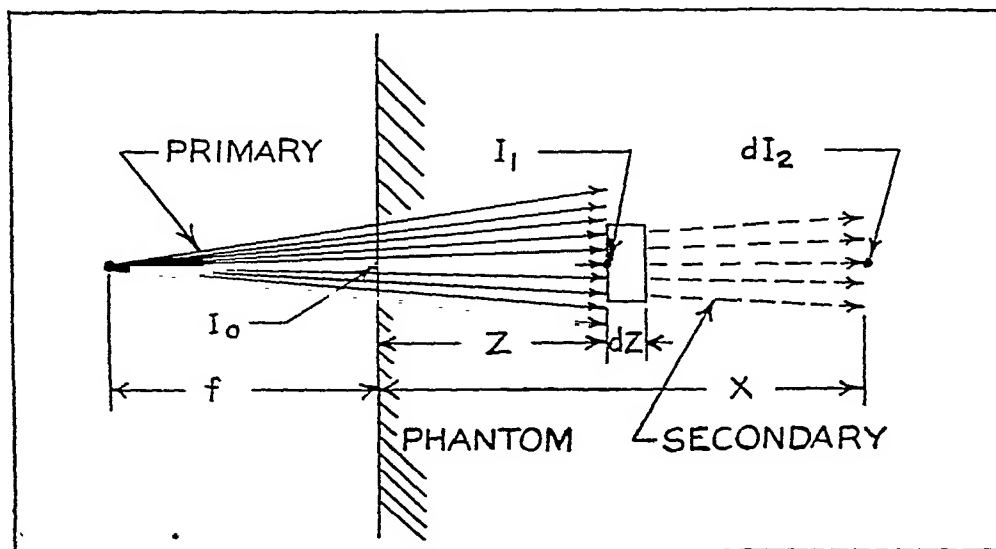


FIG. 7. Diagram to illustrate the absorption of high energy photons in a phantom.

surface of the phantom the flux density of these photons will be given by

$$I_1 = I_0 e^{-\mu_1 z} \left(\frac{f}{f+z} \right)^2 \quad (1)$$

where f is the focal skin distance and μ_1 is the absorption coefficient for the primary radiation. Between z and $z+dz$ a number $\mu_1 I_1 dz$ will be absorbed and will produce a proportional number of secondaries con-

sisting largely of Compton electrons and electron pairs. If only Compton electrons were produced the number of secondaries would be equal to the number of primary quanta involved. If only electron pairs were produced the number of secondaries would be doubled. In any case for a given type of radiation the number of secondaries pro-

duced must pass through $(x-z)$ of absorbing material and so will be reduced by the factor $e^{-\mu_2(x-z)}$.* Since we have assumed that they are all projected in the forward direction their flux density will be reduced by the factor $\left[\frac{f+z}{f+x}\right]^2$ due to in

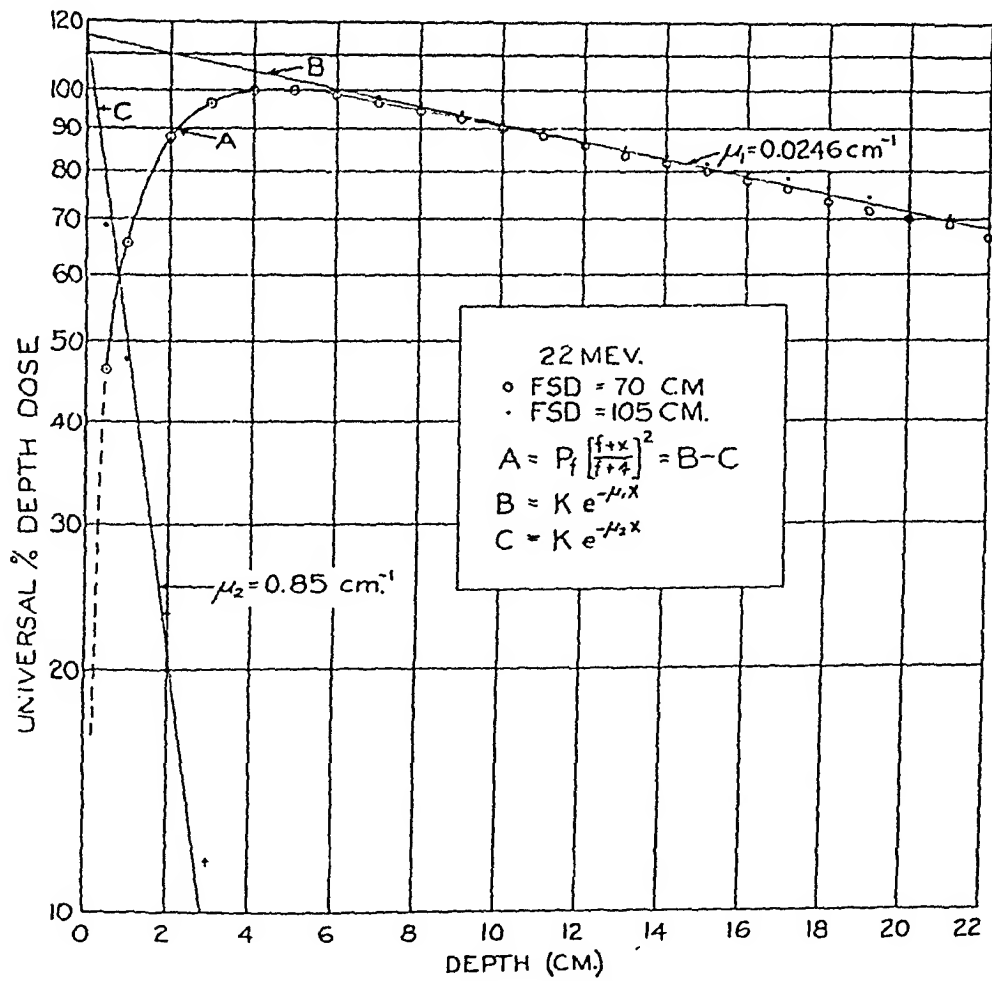


FIG. 8. Universal depth dose graph and analysis to show that the observed distribution actually can be obtained from the difference between two exponentials (22 mev. betatron radiation using a copper compensating filter).

duced will be equal to $K_1\mu_1I_1dz$ where K_1 is a constant. If we assume that all the secondaries from dz are projected in the forward direction the flux density of secondaries at a depth x will be given by

$$\begin{aligned} dI_2 &= K_1\mu_1I_1e^{-\mu_2(x-z)}\left[\frac{f+z}{f+x}\right]^2dz \\ &= K_1\mu_1I_0\left[\frac{f}{f+x}\right]^2e^{-\mu_1z+\mu_2z-\mu_2x}dz \end{aligned} \tag{2}$$

where μ_2 is the absorption coefficient for the secondaries. In reaching a depth x the

verse square law (see Fig. 7). The density of secondaries reaching a depth x will be found by integrating expression (2) from $z=0$ to $z=x$ as follows:

$$\begin{aligned} I &= \int_{z=0}^{z=x} dI_2 \\ &= \frac{K_1\mu_1I_0}{\mu_2-\mu_1} \cdot \left(\frac{f}{f+x}\right)^2 [e^{-\mu_1x} - e^{-\mu_2x}]. \end{aligned} \tag{3}$$

* The assumption of an exponential law of absorption for the secondaries is admittedly open to question because of the complicated nature of the phenomenon but appears to be justified by the results.

The ionization density shown in Figure 6 is plotted as a percentage of the maximum which occurs at 4.0 cm. depth. Hence the percentage depth dose for any depth x is given by

$$P_f = 100 \frac{I_x}{I_4} = 100 \frac{(f+4)^2}{(f+x)^2} \frac{[e^{-\mu_1 x} - e^{-\mu_2 x}]}{[e^{-\mu_1 4} - e^{-\mu_2 4}]} \quad (4)$$

$$= K \left(\frac{f+4}{f+x} \right)^2 [e^{-\mu_1 x} - e^{-\mu_2 x}].$$

In this expression the quantity $\left[\frac{f+4}{f+x} \right]^2$ gives the reduction in depth dose due to the inverse square law and the second term

sorption. For $x=4$, the above expression for P_f reduces to 100.

To test whether the actual data can be expressed by equation (4) the effect of inverse square law reduction was removed by calculating for each value of P_{70} and P_{105}

in Table I the quantity $A = P_f \left[\frac{f+x}{f+4} \right]^2$.

It was found that for any given depth the two values for A agreed with one another to better than 3 per cent on the average. Hence only the average values for A are given in Table I under the heading of Universal Depth Dose. These values are the

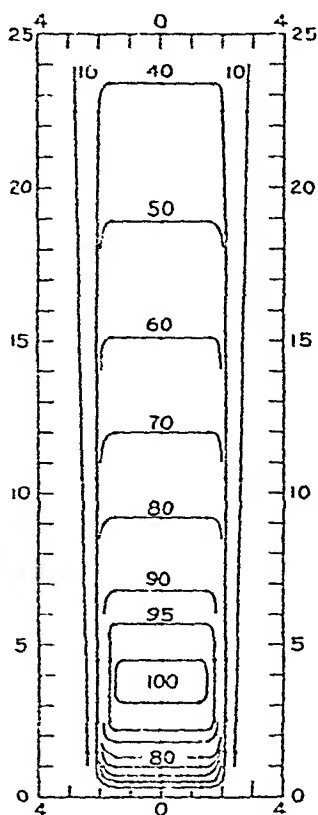


FIG. 9. Isodose distributions for a 4 cm. circular field at a focal skin distance of 70 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

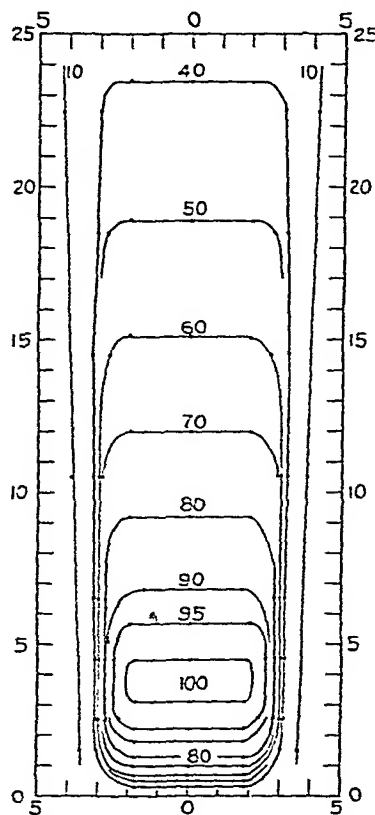


FIG. 10. Isodose distributions for a 6 cm. circular field at a focal skin distance of 70 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

$[e^{-\mu_1 x} - e^{-\mu_2 x}]$ gives the dependence of depth dose on absorption. This dependence is rather complicated for small values of x when equilibrium is being established between the primaries and secondaries. For large values of x , $e^{-\mu_2 x}$ becomes negligible and we obtain a logarithmic type of ab-

depth doses which would be obtained if there were no reduction due to inverse square law. The two values for A have been plotted in Figure 8 and it will be seen that both sets of points do lie along one curve which has the general form of the difference between two exponentials.

The graph in Figure 8 was analyzed by the standard methods yielding the two exponential curves *B* and *C* indicated in Figure 8. From the slope of lines *B* and *C* the absolute values for μ_1 and μ_2 were found to be 0.0246 cm.⁻¹ and 0.85 cm.⁻¹. The value of μ_1 is determined to within about 3 per cent while the value of μ_2 can be obtained with an accuracy of about 10 per cent. The value of μ_1 can be calculated from the

Table 1 can be used to calculate the percentage depth dose (P_f) for any depth and any focal skin distance since P_f is given by $P_f = \left[\frac{f+4}{f+x} \right]^2 \cdot A$. For example, the depth dose for $f=150$ cm. and $x=10$ cm. would be (91) $\left[\frac{154}{160} \right]^2 = 84.3$ per cent.

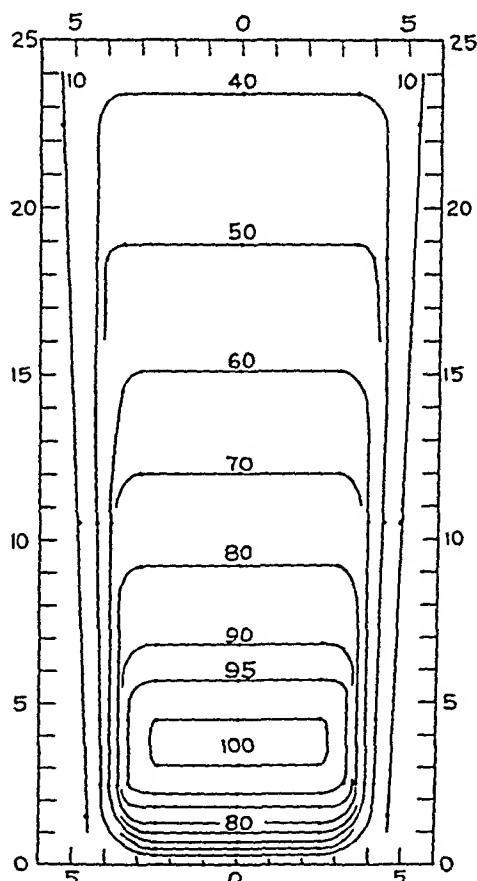


FIG. 11. Isodose distributions for an 8 cm. circular field at a focal skin distance of 70 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

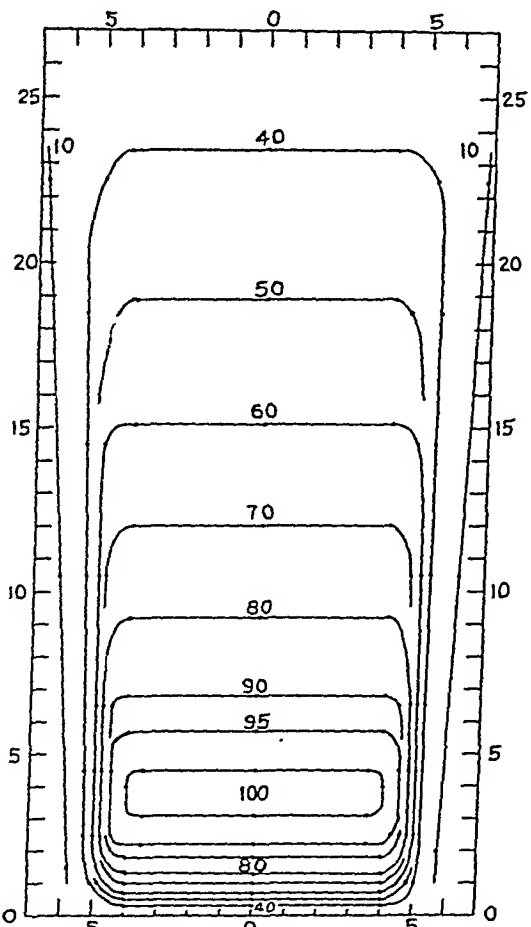


FIG. 12. Isodose distributions for a 10 cm. circular field at a focal skin distance of 70 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

known Klien-Nishina coefficients and the known cross section for pair production for water. The values for the total linear absorption coefficient are 0.051 cm.⁻¹ at 2 mev., 0.034 cm.⁻¹ at 4 mev., 0.023 cm.⁻¹ at 8 mev., 0.0185 cm.⁻¹ at 15 mev. and 0.016 cm.⁻¹ at 30 mev. The experimental linear absorption coefficient 0.0246 cm.⁻¹ obtained above is not inconsistent with these values and would correspond to an "average" photon energy of 7.5 mev.

The universal depth dose values (*A*) in

ISODOSE DISTRIBUTION

Isodose distributions for circular fields of diameter 4, 6, 8 and 10 cm. at 70 cm. focal skin distance and 6, 9, 12 and 15 cm. at 105 cm. are shown in Figures 9 to 16. These were obtained by making measurements of the radiation intensity at lattice points 1 cm. apart in a plane through the axis of the beam. Points of equal dose were connected to give the results indicated. The

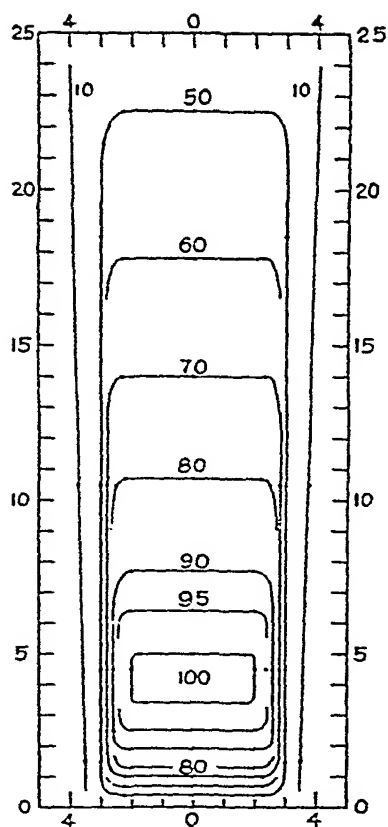


FIG. 13. Isodose distributions for a 6 cm. circular field at a focal skin distance of 105 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

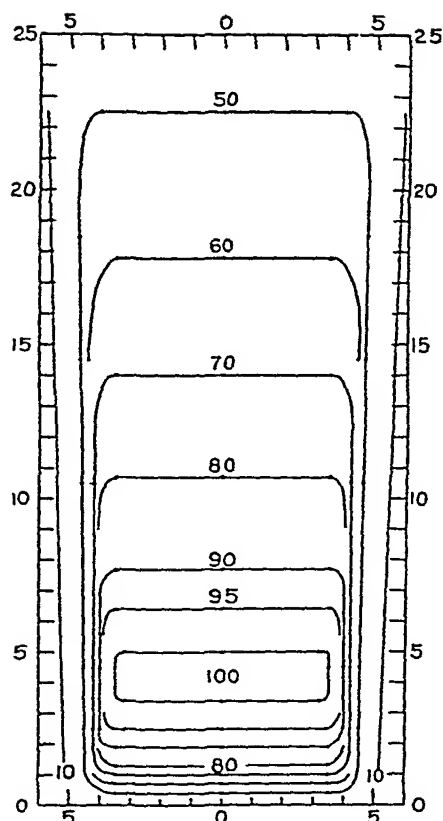


FIG. 14. Isodose distributions for a 9 cm. circular field at a focal skin distance of 105 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

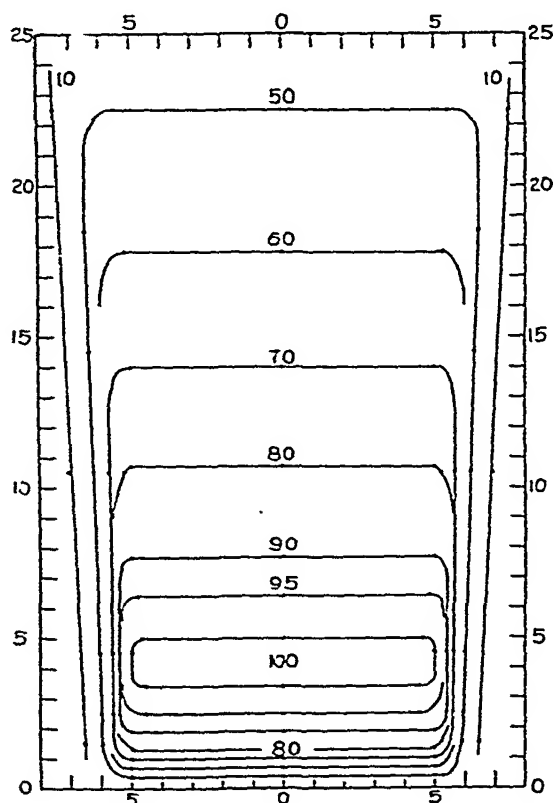


FIG. 15. Isodose distributions for a 12 cm. circular field at a focal skin distance of 105 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

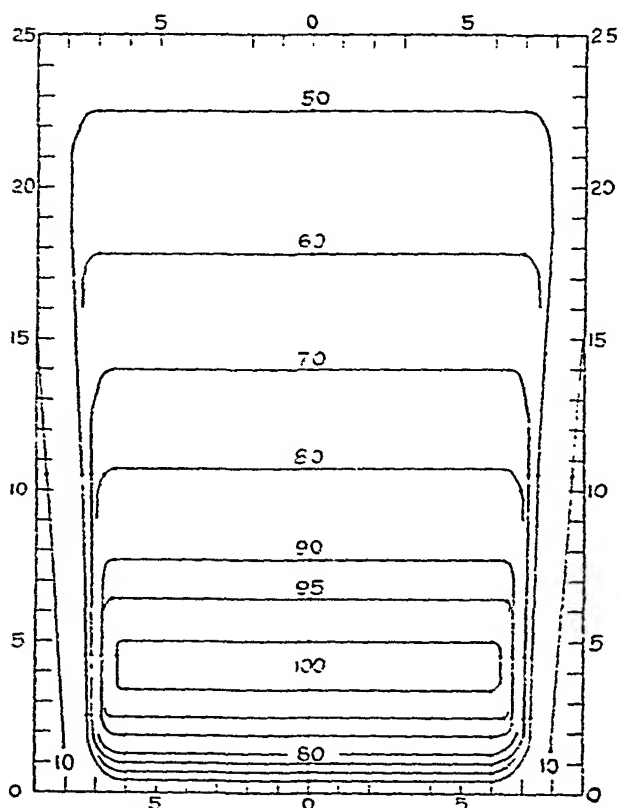


FIG. 16. Isodose distributions for a 15 cm. circular field at a focal skin distance of 105 cm. using radiation from a 22 mev. betatron with a copper compensating filter.

ionization chamber had a diameter of 6.0 mm. so that the radiation at a "point" could not be measured. This means the intensity of radiation was averaged over 6.0 mm. distance so that the contours are in error slightly in the regions where the radiation intensity changes rapidly. This means the regions of high dosage rate extend to slightly greater widths than are indicated in Figures 9 to 16. Examination of Figures 13 and 16 will indicate that if Figure 16 is selected the isodose distribution for a 6 cm. circular field (Fig. 13) can be obtained from the 15 cm. circular field by merely selecting the central 6 cm. from the larger distribution. This simplicity results from the fact that the depth dose is independent of area. It also means that the distributions in two planes at right angles for a 10 by 4 rectangular field are represented by Figures 9 and 12. It is hoped that these distributions will prove of value in formulating therapy treatments using the betatron.

SUMMARY

The roentgen-ray beam from a 22 mev. betatron has been carefully collimated and the intensity in the center of the beam reduced by the use of a copper compensating filter in such a way as to give a beam of uniform intensity over its cross section. A variety of different sized radiation fields were made available by the use of tapered lead plugs. Depth dose data were obtained in a water phantom using a small ionization chamber connected to a D.C. amplifier. It is found that the depth dose does not depend on the area of the field. A mathematical analysis of the depth dose curves indicates that they can be expressed as the

difference between two exponentials. Isodose distributions for eight fields are presented.

The authors wish to acknowledge the support of the National Cancer Institute of Canada, the National Research Council of Canada and the Saskatchewan branch of the Canadian Cancer Society. They also wish to thank Dr. T. A. Watson, Director of the Saskatoon Cancer Clinic for his many helpful suggestions concerning roentgen-ray distributions. Thanks are due to Mr. S. B. Mauchel, betatron technician, for his assistance in taking readings, and to Mr. A. H. Cox of the instrument shop of the Physics Department for his careful work.

Physics Department
University of Saskatchewan
Saskatoon, Sask.

REFERENCES

1. ADAMS, G. D., ALMY, G. M., DANCOFF, S. M., HANSON, A. O., KERST, D. W., KOCH, H. W., LANZL, E. F., LANZL, L. H., LAUGHLIN, J. S., QUASTLER, H., RIESEN, D. E., ROBINSON, C. S., and SKAGGS, L. S. Techniques for application of the betatron to medical therapy. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 153-157.
2. CHARLTON, E. E., and BREED, H. E. Some depth dose studies of roentgen rays for energy levels from 20 to 100 million electron volts. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 158-174.
3. JOHNS, H. E., DARBY, E. K., and HAMILTON, J. J. S. A negative feedback dosage rate meter using a very small ionization chamber. *AM. J. ROENTGENOL. & RAD. THERAPY*, April, 1949, 61, 550-556.
4. KOCH, H. W., KERST, D. W., and MORRISON, P. Experimental depth dose for 5, 10, 15 and 20-million-volt x-rays. *Radiology*, 1943, 40, 120-127.
5. QUASTLER, H., and CLARK, R. K. Biological evaluation of 20 million volt roentgen rays. I. Acute roentgen death in mice. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 723-727.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. Foreign Collaborators: GÖSTA FORSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San Jose, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.;
Secretary: H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio.

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fiftieth Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949.

AMERICAN RADIUM SOCIETY

President: Maurice Lenz, New York, N. Y.;
President-Elect: William S. MacComb, New York, N. Y.; *1st Vice-President:* Leland R. Cowan, Salt Lake City, Utah; *2nd Vice-President:* James A. Corscaden, New York, N. Y.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: William E. Costolow, Chairman, Los Angeles, Calif., Charles L. Martin, Dallas, Texas, A. N. Arneson, St. Louis, Mo.

Program Committee: William S. MacComb, Chairman, New York, N. Y., James F. Nolan, Los Angeles, Calif., John E. Wirth, Baltimore, Md., John V. Blady, Philadelphia, Pa.

Publication Committee: Edward H. Skinner, Chairman, Kansas City Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Research and Standardization Committee: Robert B. Taft, Chairman, Charleston, S. C., Jacob R. Freid, New York, N. Y., K. W. Stenstrom, Minneapolis, Minn.

Education and Publication Committee: James A. Corscaden, Chairman, New York, George C. Andrews, New York, A. N. Arneson, St. Louis, Mo.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: E. P. Pendergrass, Chairman, Philadelphia, Pa., John F. Hynes, Wilmington, Del., P. C. Swenson, Philadelphia, Pa.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., J. E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: 1950, to be announced.

EDITORIALS

SIXTH INTERNATIONAL CONGRESS OF RADIOLOGY

I WELCOME the Editor's invitation to contribute this Editorial because of the chance it gives me of writing about the forthcoming Sixth International Congress of Radiology in London.

All going well, there will be a few readers of this JOURNAL who have not received a preliminary Programme of the Congress as this was mailed to Radiologists, Radiobiologists and Physicists in all those countries which have appointed Delegations. I want to use this opportunity of writing in an American journal to emphasize that a very warm invitation is extended to all readers to plan to come to London in July, 1950.

We have all of us in our own countries numerous Society Conferences and Annual Meetings; even wider groups foregather, too, from time to time such as the Pan-American Congress of this year and the excellent French-speaking Countries' Radiological Congress held in Geneva a short time ago. But the International Congress has always been something much more than these, and the British Committee has every intention that it will be so again. Scientifically perhaps the subjects would appear much the same as those on any other radiological programme at the present time. Indeed, it is extraordinary how little ground one can cover in a mere week, so extensive are the ramifications of Radiology today. But the speakers now bring opinions from the whole world to the rostrum and what is said on any subject should really be, for the moment at least, the last word on that subject.

But the scientific meetings per se are not the only important aspect of such gatherings. Indeed, I often wonder whether they

are not merely the excuse—a sort of skeleton on which we hang the real flesh and blood of the Congress, the clash of minds and of ideas in private friendly intercourse. For this our International Congresses provide an opportunity on a world-wide scale. There one meets and talks to the leaders of every branch of Radiology. There one contacts like minds from all corners of the world and few should fail to find a kindred spirit, however eclectic their interest or hobby.

One thing I can promise those who come—the British Committee is very conscious of the value of informal discussion, the personal chat or gossip over coffee or the glass of beer, at dinner or at a reception, and they intend to provide adequate opportunity. But such opportunity will only serve its real function if people come determined to meet and to talk to their colleagues from countries other than their own; and, in fact, to seek them out if they are known to have worked in fields of Radiology in which the visitor is also interested. That is what the portrait catalogue is for. In addition, a ladies' programme for the wives and associate members, which looks as if it would be most attractive, has been drawn up—a programme so much more aptly described in French "programme de distraction."

I want, however, to use this Editorial to make another kind of proposal to American and Canadian Radiological Societies, Hospitals, Foundations, Governing Bodies. Travel to Europe is still a substantial expense. The leaders of Radiology, the Heads of Departments, the "high brass" of our specialty ought by now to be wealthy—or influential—enough to look after them-

selves. But what of the younger generation? For many of these, including the best intellects and the best original workers of today, the cost is heavy if self-borne entirely, and from what they learn they will bring back much of vital use to their home teams. Any hospital of any standing should be represented at such a Congress, but let them send one of their best younger men—men who would establish with their colleagues from other countries fruitful and lasting acquaintanceship founded on mutual respect. Indeed, I would like this Editorial to be taken as a form of application to governing bodies of such hospitals. Bodies such as A.E.C. and numerous cancer foundations and associations stand also to gain infinitely by being well represented at every relevant section of the Congress. Surely to send representatives from each of their institutions or laboratories is but enlightened self-interest. So can I plead with those in influential positions to get their Committees or Boards to offer Congress fellowships to well chosen members of their staffs?

One last proposal. How about the radiological societies themselves each offering

five to ten—and the smaller societies appropriately less—Congress assistance grants of say \$500 to \$750 to open competition for the under forties of their membership. Perhaps in the interests of international good-will they might also offer one or two as a gesture to societies of some of the countries still very truthfully described as “war-impooverished.”

But even if you are not wealthy and none of these ideas bear fruit in your direction my advice to all who mean to make their mark in radiology is to come anyway. Many before you have saved their pennies and travelled by old tramp steamers and now look back on Stockholm, Zurich or Paris as highlights of their radiological experience. Moreover, from the younger generation of today will come the leaders of future Congresses—and now is the time to start an association which should prove rich in experience and friendship in the years to come.

RALSTON PATERSON
President
Sixth International
Congress of Radiology



J. ERNEST GENDREAU

1880-1949

DR. J. ERNEST GENDREAU, a French-Canadian scientist of international reputation, especially interested in radiology and cancerology, and a member of the American Radium Society, died in Montreal, June 5, 1949, at the age of sixty-nine years, after a long illness.

He was the founder of the Institute of Radium of Montreal, and was one of the pioneers in physical sciences, and particularly in radiology, in Montreal. He held the Chair of Physics of the Faculty of Sciences of the University of Montreal until four years ago when he reached the age of retirement, at which time he was made professor

emeritus. Two years ago he resigned from the direction of the Institute of Radium because of his poor health. His clinical studies were pursued in Canada and supplemented by periods of study in various European universities. He held the titles of Doctor of Medicine, Doctor of Philosophy, and Licentiate in Sciences, all obtained in Paris. He was formerly assistant to Drs. Jaugeas and Bécclère in radiology; Madame Curie, Langevin and Regaud in radioactivity. After ten years of study in European universities he returned to Montreal where he founded the Institute of Radium.

JAMES T. CASE, M.D.



LUDWIG HALBERSTAEDTER

1877-1949

WHILE on a visit to the United States Dr. Halberstaedter died suddenly on April 21, 1949, at the age of seventy-two. He was born in Beuthen, Silesia, in 1877 and studied medicine at Breslau. He was one of the pioneer radiologists, becoming interested in radiations and publishing papers on light therapy and on roentgen rays in 1904 and 1905. After World War I he became Director of the Radiotherapy Section of the Berlin Cancer Institute. Dr. Halberstaedter was the first to recognize the specific action of roentgen rays on the ovaries and this recognition formed the basis for a great part of radiotherapy in gynecology. He also did important work on the treatment of skin cancer with radium molds. As

early as 1932 he began work on million volt roentgen rays and cathode rays but in 1933 he was requested to resign his hospital appointment in Berlin and he considered it wise to leave Germany and went with his wife to Palestine. Here he took charge of radiotherapy at the Hadassah Hospital in Jerusalem and continued his research work at the Hebrew University, publishing many papers. At the time of his death he was Professor of Radiology at the Hebrew University and Chief of the Cancer Laboratories in Palestine.

Dr. Halberstaedter was well known personally to many American radiologists and he was a great scientist and friend.

IRA I. KAPLAN, M.D.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4-7, 1949.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1950, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill. Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY

Secretary, D. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. Joseph Daversa, 603 Fourth Ave., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg.,

Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. F. H. Ghiselin, 111 East 76th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Boyd Isenhardt, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.

Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:

New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. J. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Andreilino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloriast. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

HOTEL RESERVATIONS

AMERICAN ROENTGEN RAY SOCIETY

The July issue of the JOURNAL carries the Preliminary Program and the Instruction Courses for the meeting of the American Roentgen Ray Society to be held at the Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949. In the Editorial in that issue attention was called to the importance of making hotel reservations at an early date. This is again emphasized. While the Netherland Plaza and the Terrace Plaza have been most generous in their allotment of rooms for those attending the meeting, it will still be necessary to use other Cincinnati hotels in close proximity to the meeting place. An adequate guarantee of rooms has been made by all these hotels in cooperation with the Convention Bureau but these rooms will be held for the Society only up to thirty days in advance of the meeting.

It is therefore urged that all those who contemplate attending the meeting in Cincinnati make their reservations at once. It is always easier, if at the last minute something unforeseen prevents attendance at the meeting, to cancel a reservation than it is to secure a room at a late date.

Cooperation in this respect by everyone anticipating attending the meeting will be appreciated by the hotels, the Convention Bureau and the Society. All reservations should be made through the Netherland Plaza Hotel, Cincinnati 2, Ohio.

ATLANTA RADIOLOGICAL SOCIETY

A called meeting of the radiologists of the city of Atlanta was held on the evening of March 11, 1949. At that meeting it was decided that a society of radiologists should be formed in the city of Atlanta, this society to be named the Atlanta Radiological Society. The following officers were elected: *President*, Dr. J. J. Clark; *Vice-President*, Dr. Charles A. Priviteri; *Secretary-Treasurer*, Dr. William W. Bryan. Meetings will be held monthly, except during the three summer months, on the second Friday evening.

KINGS COUNTY RADIOLOGICAL SOCIETY

At a recent meeting, the name of the Long Island Radiological Society was changed to the Kings County Radiological Society. The following officers were elected for the ensuing year: *President*, Dr. H. G. Koiransky; *Vice-President*, Dr. I. Silverstein; *Secretary*, Dr. Marcus Wiener (re-elected); *Treasurer*, Dr. M. H. Goldenberg.

NEW YORK ROENTGEN SOCIETY

At a recent meeting of the New York Roentgen Society the following officers were elected for the coming year: *President*, Dr. William Snow; *Vice-President*, Dr. Robert P. Ball; *Secretary*, Dr. F. H. Ghiselin; *Treasurer*, Dr. Harold L. Temple.



ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

- McRAE, DONALD L.: Focal epilepsy..... 279
 WYATT, J. P., and GOLDENBERG, H.: Cranio-
 lacunia..... 280
 WEBER, G.: Diagnosis and therapy of cerebral
 arteriovenous aneurysms..... 280
 WOLFE, H. R. I.: Unexplained thrombosis of
 the internal carotid artery..... 280
 JACOBY, N. M., and SAGORIN, L.: Human
 toxoplasmosis in England..... 280
 SCHULZ, M. D., and HEATH, P.: Lymphoma of
 the conjunctiva..... 280

Neck and Chest

- MEYER, A. C., DOCKERTY, M. B., and HARR-
 RINGTON, S. W.: Inflammatory carcinoma
 of the breast..... 281
 TICE, G. I., DOCKERTY, M. B., and HARRING-
 TON, S. W.: Comedomastitis..... 281
 BRADBURY, F. C. S.: Minimal requirements for
 mass radiography..... 282
 TATTERSALL, W. H.: Diagnostic fluoroscopy at
 a chest clinic..... 282
 HORST, H. G., LEGLER, H., and BUCHTALA, V.:
 Differential diagnosis of multiple pulmo-
 nary densities..... 282
 FLEISCHNER, F. G.: Visible bronchial tree.... 282
 BULGRIN, J. G.: Unusual Friedländer's bacillus
 pneumonia associated with septicemia.... 283
 HERBERT, F. J.: Pulmonary tuberculosis in the
 old..... 283
 MEDLAR, E. M., SPAIN, D. M., and HOLLIDAY,
 R. W.: Disregarded seedbed of tubercle
 bacillus..... 283
 JONES, D. B.: Basal pleural fluid accumula-
 tions resembling elevated diaphragms.... 284
 SCHNEIERSON, S. J., and SCHNEIDER, L.: Lipoid
 granulomatosis (xanthomatosis) with
 marked pulmonary fibrosis and cor pul-
 monale as outstanding manifestations.... 284
 LINDSKOG, G. E., and BLOOMER, W. E.: Bron-
 chogenic carcinoma..... 285
 AGATE, J. N.: Delayed pneumonitis in a beryl-
 lium worker..... 285
 DOTTER, C. T., and STEINBERG, I.: Angio-
 graphic study of the pulmonary artery... 285

- NEMEC, S. S.: Differential diagnosis of retro-
 cardiac shadows..... 286
 GROSS, R. E., and HURWITT, E.: Cervicomedi-
 astinal and mediastinal cystic hygromas.. 286
 SENGPIEL, G. W., RUZICKA, F. F., and LOD-
 MELL, E. A.: Lateral intrathoracic men-
 ingocele..... 287

Abdomen

- WHITEHOUSE, F. R., and KERNOHAN, J. W.:
 Myenteric plexus in congenital mega-
 colon..... 287
 CULVER, G. J., and KLINE, J. R.: Acute gase-
 ous cholecystitis..... 287
 JANUS, W. L.: Regional jejunitis..... 287
 FELDMAN, M.: Statistical study of life cycle of
 1,154 cases of duodenal ulcer..... 288
 RAFSKY, H. A., WEINGARTEN, M., and
 KRIEGER, C. I.: Onset of peptic ulcer in
 the aged..... 288
 WALTERS, W., *et al.*: Results of vagus nerve re-
 sections in treatment of peptic ulcer.... 288
 MARSHALL, S. F., and WELCH, M. L.: Results
 of surgical treatment for gastric ulcer.... 289
 THOMPSON, H. L.: Complications of peptic
 ulcer..... 290
 ST. JOHN, F. B., *et al.*: Results following sub-
 total gastrectomy for duodenal and
 gastric ulcer..... 290
 MOORE, G. E., STATE, D., HEBBEL, R., and
 TRELOAR, A. E.: Carcinoma of the
 stomach..... 291
 BEYNON, A. E.: Primary carcinoma of the
 liver in a boy aged 15..... 291
 NICKELL, D. F., and DOCKERTY, M. B.: Five
 year survival rate in cases of completely
 obstructing annular carcinoma of de-
 scending colon and sigmoid..... 291
 BLACK, W. A., and WAUGH, J. M.: Intra-
 mural extension of carcinoma of de-
 scending colon, sigmoid and rectosig-
 moid..... 292

Genitourinary System

- HENLINE, R. B., and HAWES, C. J.: Uretero-
 pelvic obstructions..... 292
 IRVIN, G. E., and KRAUS, J. E.: Congenital
 megaloureter and hydroureter..... 293

- HERBST, W. P.: Posteriorly located renal pelvis associated with ptosis..... 293
- ABOWITZ, J.: Obstructive hydronephrosis produced by aberrant blood vessels and diagnosed by intravenous urography..... 293
- RUDHE, U.: A typical roentgen picture of very large ureterocele..... 294
- PERRY, S. P., and HADEN, W. D.: Accidental filling of urinary tract during barium enema..... 294
- Nervous System*
- BRIERLEY, J. B., and FIELD, E. J.: Connexions of the spinal sub-arachnoid space with the lymphatic system..... 294
- NAFFZIGER, H. C., and BOLDREY, E. B.: Cancer of the nervous system..... 294
- Skeletal System*
- MESCHEN, I., and MCGAW, W. H.: Newer methods of pneumoarthrography of knee with evaluation of procedure in 315 cases. 295
- JACOBS, L. G.: Isolated fracture of pisiform bone..... 296
- COLES, W. C., and SCHULTZ, M. D.: Bone involvement in malignant lymphoma..... 297
- PLATT, J. L., and EISENBERG, R. B.: Eosinophilic granuloma of bone..... 297
- BABAŁANTZ, L.: Atrophic osteopathies..... 297
- MARQUES, P., GRIMOUD, M., and POUCH, G.: Malignant degeneration of giant cell tumors of bone..... 298
- SHERMAN, R. S., and PEARSON, T. A.: Roentgenographic appearance of renal cancer metastasis in bone..... 298
- BICKEL, W. H., *et al.*: Streptomycin in tuberculosis of bone and joint..... 298
- JAFFE, H. L., and LICHTENSTEIN, L.: Chondromyxoid fibroma of bone..... 299
- TOONE, E. C., JR.: Rheumatoid spondylitis.. 299
- WERTHEIMER, L. G.: Coracoclavicular joint.. 300
- ARKIN, A. M., and SCHEIN, A. J.: Aseptic necrosis in Gaucher's disease..... 300
- HOWORTH, M. B.: Coxa plana..... 301
- GHORMLEY, R. K., and CLEGG, R. S.: Bone and joint changes in hemophilia..... 302
- HORWITZ, T.: Bone and cartilage debris in synovial membrane..... 303
- GRANT, F. C., *et al.*: Correlation of neurologic, orthopedic and roentgenographic findings in displaced intervertebral discs..... 304
- BARTELINK, D. L.: Myelography in intervertebral disc protrusion..... 304
- ALBERTENGO, J. B.: Diagnosis and treatment of lumbar intervertebral disc hernia.... 305
- GURI, J. P.: Tumors of vertebral column.... 305
- BRAY, E. A., MOITER, H. A., and NEWCOMB, W. J.: Lumbosacral articulation..... 306
- RIKER, W., and POTTS, W. J.: Sacrococcygeal teratomata in infancy..... 307
- LONGSTRETH, H. P., BLANCO, P., and SANES, S.: Myxochondrosarcoma of the talus.... 307
- REICH, C., and BRODSKY, A. E.: Coexisting multiple myeloma and Paget's disease of bone treated with stilbamidine..... 307
- Blood and Lymph System*
- HOSTER, H. A., DRATMAN, M. B., CRAVER, L. F., and ROLNICK, H. A.: Hodgkin's disease..... 308
- JACKSON, H., JR.: Practical aspects of diagnosis, treatment and prognosis of Hodgkin's disease and allied disorders..... 308
- HARE, H. F., MULRY, W. C., and SORNBERGER, C. F.: Lymphoid tumors..... 308
- MOFFITT, H. C., and LAWRENCE, J. H.: Chronic leukemia of long duration..... 309
- FARBER, S., *et al.*: Temporary remissions in acute leukemia in children produced by folic acid antagonist, 4-aminopteroyl-glutamic acid (aminopterin)..... 309
- UHLMANN, E. M.: Significance of giant follicular lymphadenopathy..... 310
- CALME, A.: Employment of a new iodized substance in arteriography and phlebography..... 310

ROENTGEN DIAGNOSIS

HEAD

McRAE, DONALD L. Focal epilepsy; Correlation of the pathological and radiological findings. *Radiology*, April, 1948, 50, 439-457.

The author discusses classification on anatomical basis, and changes seen on plain roentgen films of skull and by encephalography on 160 patients with focal epilepsy due to atrophic cerebral and meningocerebral lesions.

The most common atrophic lesion, meningo-

cerebral cicatrix, was associated with localized bony abnormalities, namely, old fracture, old bone defect, craniocerebral erosion, or localized thinning and bulging of the bone in 66 per cent of cases. Reduction in volume of one lateral chamber of skull noted in half of the cases. The incidence of localized bone changes is six times greater than in any other type of lesion. Craniocerebral erosion seems to be a specific finding. Pneumograms demonstrated focal ventricular dilatation in 80 per cent of the patients with meningocerebral cicatrix.

The second largest group consists of simple atrophic lesions, namely, focal microgyria, cerebral cicatrix secondary to arterial or venous occlusions, and brain cysts secondary to cerebral hemorrhage. Localized bony abnormalities occurred in only 11 per cent of this group. Cranial hemiatrophy was present in about half of the cases. Focal ventricular dilatation was demonstrated in 38 per cent and subarachnoid cysts in 5 per cent of these patients.

The third group included blood vessel anomalies. Intracerebral calcification is a common finding. Occasionally changes were found suggesting a space-occupying lesion.

The demonstration of a focal atrophic lesion did not always localize the epileptogenic focus.—*E. E. Seedorf, M.D.*

WYATT, J. P., and GOLDENBERG, H. Cranio-lacunia. *Arch. Path.*, May, 1948, 45, 667-677.

This paper is a report of 6 cases of cranio-lacunia (Lückenschädel) found at autopsy in one year at the Toronto East General Hospital (representing about 10 per cent of their 62 still-born and neonatal deaths) along with a brief review of the literature. In their 6 cases the authors found defects only in the membranous bones—the abnormalities being similar in all but extent and degree. The defects were primarily of the inner tables, sometimes both tables, and they were surrounded by interlacing bony ridges. The defects do not conform to the convolutions of the brain, nor to the centers of ossification. In all cases there were associated anomalies involving the central nervous system, the most frequent being spina bifida and meningocele, as has been previously reported. The authors do not consider increased intracranial pressure per se to be the vital etiological factor, leaning more to the view that it is simply an anomaly of skeletal development.—*D. D. Beiler, M.D., and C. L. Hinkel, M.D.*

WEBER, G. Zur Diagnose und Behandlung der arteriovenösen Aneurysmen im Bereich der Grosshirnhemisphären. (The diagnosis and therapy of cerebral arteriovenous aneurysms.) *Schweiz. med. Wchnschr.*, July 3, 1948, 78, 629-634.

Cerebral arteriography is regarded as particularly valuable in the diagnosis of cerebral arteriovenous aneurysms. In the 15 cases observed by the author, only in 4 could a systolic-diastolic murmur be heard over the temporal regions. None of his cases had any detectable

calcifications roentgenologically. Encephalography revealed dilated ventricles in 5 and a deviation of one ventricle in 1 instance only. Cardiac enlargement or unilateral exophthalmos was not observed. The author's indications for cerebral arteriography are (1) history of subarachnoid hemorrhage, (2) unilateral jacksonian attacks without encephalographic findings, (3) combination of subarachnoid hemorrhage and jacksonian attacks.—*Arthur Grishman, M.D.*

WOLFE, H. R. I. Unexplained thrombosis of the internal carotid artery. *Lancet*, Oct. 9, 1948, 2, 567-569.

A case of complete occlusion of the left internal carotid artery in a female, aged twenty-six, is presented. This is the only case of complete occlusion the author found in 35 cases described in the literature. Thirty-two previously described cases diagnosed by arteriography are discussed as to pathology, diagnosis and treatment. The angiogram of the present case is reproduced showing a cone-shaped termination of the thorotrast column just below the atlas.—*J. S. Summers, M.D.*

JACOBY, N. M., and SAGORIN, L. Human toxoplasmosis in England. *Lancet*, Dec. 11, 1948, 2, 926-928.

Although the presence of toxoplasma in animals was described in England as early as 1914, this is the first recorded case in a human in that country.

Only one case, that of a male infant four months of age, is presented. There is a photograph of the typical "scissors" position and a reproduction of the skull films showing calcification.

The author concludes that the disease may well be more common in England than is supposed. Cases may be misdiagnosed congenital chorioretinitis, encephalitis and chronic meningitis.—*J. S. Summers, M.D.*

SCHULZ, MILFORD D., and HEATH, PARKER. Lymphoma of the conjunctiva. *Radiology*, April, 1948, 50, 500-505.

Authors present 14 lymphomas taken from 1,600 records of patients with lymphomas of all varieties. Five of them were female, and 9 male. In this series the disease was found in elderly patients, almost half of the group being more than seventy years of age and all but 3 over fifty years of age.

Cytologically, 11 of the 14 were lymphocytomas, two having predominantly reticulum cells and another had many lymphoblasts.

None of the 14 patients showed an abnormal blood picture at time of entry. Of the tumors localized to the conjunctiva, 4, or 50 per cent, were infiltrative and none showed evidence of recurrence or remote manifestations. Of the 6 with remote disease, all but 2 were invasive tumors, lymphosarcoma, and all promptly succumbed to their disease except one. This histopathologic character of lymphomatous disease seems to have no conclusive bearing on prognosis.

All tumors were treated with radium or roentgen radiation save two which were excised. Treatment factors, 200 kv., 20 cm. object target distance, 0.25 mm. copper filter. Daily dose of 200 to 300 r was given, directed to conjunctiva for a total of 600 to 900 r. No untoward effect noted upon eye.

None of the patients in whom the lymphoma was localized to the conjunctiva when first seen has had reappearance of disease after treatment. Six have been well two years or more; 2 with invasive tumors more than five years. In contrast, all of the patients whose conjunctival involvement was part of a generalized lymphoma were dead in less than two years or have uncontrolled disease. The eyes in none, however, show recurrence.—*Robert D. Moreton, M.D.*

NECK AND CHEST

MEYER, ALFRED C., DOCKERTY, MALCOLM B., and HARRINGTON, STUART W. Inflammatory carcinoma of the breast. *Surg., Gynec. & Obst.*, Oct., 1948, 87, 417-424.

That certain malignant lesions of the breast may simulate inflammatory lesions clinically has long been a matter of common knowledge. Although clinically these lesions do not present the usual picture of carcinoma of the breast and often have been mistaken for inflammatory lesions, pathologically they represent a very virulent type of cancer.

The purpose of this study was to describe and classify this type of disease, to investigate its pathologic characteristics and to correlate its clinical manifestations with its pathologic characteristics.

Summary

In 74 (1 per cent) of approximately 7,000 cases of malignant lesion of the breast, the

diagnosis was inflammatory carcinoma because of characteristic clinical features which simulated those of inflammation. The disease was found to occur in the same general age group as carcinoma of the breast and there was no particular correlation with pregnancy or lactation. The incidence of bilateral malignancy was two times that noted in comparable cases of the usual carcinoma of the breast. The left breast was affected primarily nearly twice as frequently as the right. On examination both breasts were large and often the involved one had become bigger than its mate. The skin over the breasts was red or edematous or both, and palpation frequently revealed diffuse infiltration rather than a localized tumor. The axillary nodes were involved in all cases.

Pathologically the lesions were diffuse, high grade adenocarcinomas which frequently involved the lymphatics and occasionally the blood vessels. Characteristically the cancer spread through the subepidermal lymphatics. There was no evidence of bacterial infection, and ulceration of the skin was extremely rare. The inflammatory appearance was apparently due to blockage of the lymphatics by cancer cells and the resultant vascular phenomena.

Prognosis for life is poor but 3 patients lived more than five years after operation and 1 was alive nine years after operation.

The common sites of metastasis were the thorax, bone, the opposite breast and the skin. Occurrence of metastasis to the skin was especially frequent, having been present in 55 per cent of the cases in which metastasis was known to have occurred.—*Mary Francis Vastine, M.D.*

TICE, GEORGE I., DOCKERTY, MALCOLM B., and HARRINGTON, STUART W. Comedomastitis; clinical and pathologic study of data in 172 cases. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 525-540.

Comedomastitis is a disease of the breast characterized by dilatation of the lactiferous ducts which are distended with inspissated grumous material that may be expressed from the cut ends of the ducts much as comedones are expressed from ordinary blackheads. It is a disease of the large ducts in contrast to chronic cystic mastitis which is a disease of the acini and ductules. Marked clinical similarity to mammary malignancy may be present when comedomastitis results in an indurated area of the breast which is fixed to the skin and is as-

sociated with a retracted nipple. Even the pathologic picture may be confused with that of carcinoma unless the true nature of the lesion is appreciated.

Conclusions.

1. Comedomastitis is a disease characterized by stasis of secretion, dilatation of the ducts, and periductal mastitis.

2. The clinical features of the disease vary widely, but the disease may be suspected in the presence of a history of abnormality of lactation, nonpuerperal mastitis, discharge from the nipple or abnormality of the nipple. On examination the lesion may closely simulate carcinoma because of the indurated, fixed mass and retracted nipples.

3. Comedomastitis usually is associated with chronic cystic mastitis which may overshadow it clinically.

4. Neoplasia, although it occasionally occurs in the same breast as does comedomastitis, is probably not related to the latter etiologically. By simple obstruction of the mammary ducts such neoplastic changes may, at times, produce a focal comedomastitis.

5. Plasma cell mastitis is probably a form of comedomastitis.—*Mary Frances Vastine, M.D.*

BRADBURY, F. C. S. Minimal requirements for mass radiography. *Lancet*, Aug. 21, 1948, 2, 293.

There is a lower limit to the efficiency of mass roentgenography, below which it becomes uneconomical. The author suggests that this lower limit would be the point where mass roentgenography leaves undiscovered more tuberculosis than it discovers.

On this basis not less than 70 per cent of any group to be surveyed should be actually examined if the return is commensurate with the expense.

The figure 70 per cent was chosen because in a series of mass surveys the amount of tuberculosis detected was shown to be directly proportional to the percentage response from any given group. That means that of the 70 per cent who had films made, only 70 per cent of the expected incidence of tuberculosis will be detected. Hence, if 100 per cent examination gives all the detectable tuberculosis, a 70 per cent response will give only $(70)^2/100$, or 49 per cent, of all the detectable tuberculosis.

Therefore, not less than 70 per cent of any group to be surveyed must be examined if the

venture is to be an economical success.—*J. S. Summers, M.D.*

TATTERSALL, W. H. Diagnostic fluoroscopy at a chest clinic. *Lancet*, Dec. 18, 1948, 2, 974-975.

The author is a chest physician of Reading, England, who believes that fluoroscopy in skilled hands can gain a high degree of accuracy without danger to the patient or operator.

Because of the fluoroscope's advantages of cheapness and rapidity of use he offered a rapid fluoroscopy service. During the two years of operation of this service, 2,908 patients have been examined. Three hundred fourteen cases were selected for roentgenography and further study. Eighty-three (26 per cent) of these were found to have tuberculosis. This means an overall discovery of 3 per cent tuberculosis in 2,908 cases. Thirty-two (39 per cent) of the 83 had positive sputum. No false negative reports have been found.

The author believes that 20 people can be adequately examined in half an hour but stresses complete dark adaptation.—*J. S. Summers, M.D.*

HORST, H. G., LEGLER, H., and BUCHTALA, V. Beitrag zur Differentialdiagnose der multiplen Herdschatten der Lunge. (Contribution to the differential diagnosis of multiple pulmonary densities.) *Schweiz. med. Wchschr.*, June 5, 1948, 78, 543-544.

Two cases of transient pulmonary edema with hemoptosis are described. In the first case the patient fell into a river while working near it. He was admitted to the hospital in an unconscious condition. Since rales were heard a chest roentgenogram was taken which showed multiple lobular cherry-sized infiltrations, particularly in the perihilar region. There was rapid recovery with one recurrence.

The second patient was suffering from epilepsy, being admitted half an hour after an attack of pulmonary edema. The chest roentgenogram similarly showed numerous, confluent bronchopneumonic-like consolidations.

To think of pulmonary edema of central origin in drowning accidents or acute cerebral episodes is clinically important since often no adequate history can be obtained in such cases.—*Arthur Grishman, M.D.*

FLEISCHNER, FELIX G. The visible bronchial tree; a roentgen sign in pneumonic and other

pulmonary consolidations. *Radiology*, Feb., 1948, 50, 184-189.

The air-filled bronchial tree, not roentgenographically visible in a normal chest, may become visible as a ramifying system of radio-lucent strands within a radiopaque field in the presence of lung disease causing absence of normal parenchymal alveolar aeration. The author presents several cases illustrating the diagnostic usefulness of this "visible bronchial tree" sign. It is most frequently helpful in recognizing all types of minimal pneumonic consolidation, especially in infants and children, and in obscure retrocardiac, basal, or lower lobe location. Infarction, tumors, bronchiectasis, and atelectasis may also show this sign.

The author describes an experiment demonstrating the reason for the sign. Crossed rows of paraffin-filled and air-filled paper drinking straws were roentgenographed twice in an open, paraffin-coated, paper box, once containing air, and once filled with water. Only the paraffin-filled straws were visible on the roentgenogram of the box containing no water. Only the air-filled straws were visible, as black lines in a white field, on the roentgenogram of the box filled with water.

Absence of the sign does not rule out pneumonic consolidation, since failure to demonstrate the bronchi may be due to the bronchial air being displaced by secretion, edema fluid, or blood, or due to over- or under-exposure of the roentgenograms.—*Richard E. Lukes, M.D.*

BULGRIN, JAMES G. Unusual Friedländer's bacillus pneumonia associated with septicemia. *Radiology*, April, 1948, 50, 526-528.

The author presents a report of an unusual case of Friedländer's bacillus pneumonia associated with septicemia due to that organism and characterized by nodular pulmonary densities of a type usually seen with tuberculosis or metastatic neoplasm. Complete resolution was obtained by streptomycin therapy.

A review of the literature reveals no similar case due to Friedländer's bacillus.

Due to the efficiency of antibiotic therapy, recognition of unusual pulmonary lesions associated with septicemia of any kind is important.—*Robert D. Moreton, M.D.*

HERBERT, F. J. Pulmonary tuberculosis in the old. *Lancet*, Aug. 14, 1948, 2, 247-249.

Pulmonary tuberculosis in the aged is not rare and it may be highly infective. The present

study covers the years 1938-1946 at the Stobhill Hospital, Glasgow. Sixty-nine cases of tuberculosis were found in patients over sixty years of age. Sixty of these were men. The higher rate in men was attributed to the fact that the majority of these men lived in "model lodging houses" which necessitated their admission to the hospital for even minor nursing care. More women presumably lived in homes where minor nursing care could be provided.

Tubercle bacilli were found in the sputum in 34 of the 69 cases. In 30 of the 35 cases with negative sputum, the examinations were considered in retrospect to have been inadequate.

A positive family history was obtained in only 13 cases (22 per cent). A previous history of pleurisy or of treatment for tuberculosis was given in 20 cases out of 63 (32 per cent).

Roentgen reports were available in 57 cases (83 per cent). Fibroid disease was present in 29 cases (51 per cent of the 57 cases) and it was bilateral in 15 (26 per cent). Active (fibro-caseous) disease was found in 24 cases (42 per cent). This was bilateral in 8 (14 per cent). There were 4 unclassified cases.

The author concludes that more attention should be directed to the problem of pulmonary tuberculosis in the aged. It has an insidious onset with symptoms commonly ascribed to old age. It is often an active process with a high proportion of sputum positive cases, dangerous to younger people around them.—*J. S. Summers, M.D.*

MEDLAR, E. M., SPAIN, DAVID M., and HOLLIDAY, ROBERT W. Disregarded seedbed of the tubercle bacillus. *Arch. Int. Med.*, April, 1948, 81, 501-715.

To determine the incidence of deaths from tuberculosis and of unhealed tuberculosis in persons who died from other diseases the necropsy records of Bellevue Hospital on adult patients over fifteen years of age were examined for a ten year period.

In 40 per cent of the cases involving persons over fifty years of age with unhealed pulmonary tuberculosis this disease was not mentioned in the clinical diagnosis. Of this group, 77 per cent were white males, of whom one-half had cavity formation in the lungs. A clinical recognition of the tuberculosis would not have altered the primary clinical diagnosis or the treatment prescribed in the majority of instances. However, failure to recognize the presence of pathologically active tuberculosis precluded

steps to lessen the danger of spread of the infection.

Among patients who died from tuberculosis the clinical diagnosis was incorrect six times more often for persons over fifty than for persons under thirty years. Among patients who died from other diseases, but who harbored tuberculosis which was capable of spreading, there was clinical recognition of tuberculosis in only one-fourth. Tuberculosis tends to be less explosive in type in old persons than in young adults. Older persons can have progressive disease with so few manifestations of illness that they may not seek the advice of a physician. In these circumstances they remain unrecognized spreaders of the infection.

In a high proportion of new cases of tuberculosis in adults in New York city, the disease is apparently contracted from unrecognized sources of infection. Mortality rates, encouraging as they seem do not indicate either the extent or the location of the seedbed in which the tubercle bacillus resides. The seedbed may well be greater in extent today than it was twenty years ago, for it is largely concentrated in persons, principally men, over forty-five years of age, and these are more numerous today than they were a generation ago. The seedbed must be controlled if the continuity of the disease is to be broken.—*Eugene J. McDonald, M.D.*

JONES, DEAN B. Basal pleural fluid accumulations resembling elevated diaphragms. *Radiology*, Feb., 1948, 50, 227-233.

The occurrence of a collection of fluid between the basal surface of the lung and the superior surface of the diaphragm may yield a roentgenographic appearance simulating elevation of the diaphragm. This must be distinguished from true inflammatory or neoplastic subphrenic disease, diaphragmatic paralysis, atelectasis, herniation or eventration of the diaphragm, and intrapleural or intrapulmonary neoplastic disease.

The author presents 5 such cases and demonstrates in their differential diagnosis the utility of pneumoperitoneum, lateral decubitus roentgenograms, pleural tap, and accentuation of the stomach bubble by giving the patient a carbonated drink prior to examination.

The behavior of fluid within the pleural space is influenced by retractility or elasticity of lung tissue, capillary cohesion between the pleural surfaces, surface tension and viscosity of the fluid, and the presence of gas in the

pleural space. The author believes of major importance in the basal location of fluid is the factor of retractility altered locally by fibrinoplastic adhesions of visceral to parietal layers of the pleura.—*Richard E. Lukes, M.D.*

SCHNEIERSON, SAMUEL J., and SCHNEIDER, LOUIS. Lipoid granulomatosis (xanthomatosis) with marked pulmonary fibrosis and cor pulmonale as outstanding manifestations. *Ann. Int. Med.*, April, 1949, 30, 842-851.

Largely as a result of the contributions of Hand, Schüller, and Christian, "xanthomatosis" of the skeletal type became clearly established as a disease found principally in children. The clinical manifestations of the peculiar pathological process were described as defects in membranous bones, exophthalmos and diabetes insipidus, and were all attributable to "xanthomatous" involvement of membranous bones (chiefly skull) and of the hypothalamus.

Pulmonary infiltration has been observed by a number of authors. Most often it proves to be an incidental finding discovered in the course of chest roentgen examination, in a patient with other symptomatic manifestations of the disease. Pulmonary infiltration extensive enough to result in congestive right heart failure (as in this case) is distinctly rare. Of interest also is the fact that in a pre-employment chest roentgenogram at least two years before symptoms of the disease appeared, there was evidence of extensive pulmonary infiltration.

Confronted with such an instance, the clinician embarks on a search for etiological factors. Usually the possibility of lipoid granulomatosis is not considered. It now seems that in any instance of otherwise unexplained pulmonary fibrosis, especially in children or young adults, this entity must be kept in mind. Further interrogation of the patient and bone roentgenograms, especially of the skull, may conceivably add other cases similar to this one.

This article represents a single case of this condition. The patient is thirty-five years old, male, who had a routine chest study showing uniformly fuzzy, bilateral symmetrical infiltration throughout both lung fields. He was asymptomatic for two years when another roentgenogram of the chest showed no significant change. All laboratory studies were within normal limits. Clinical impression was that of diffuse pulmonary fibrosis, cause undetermined. He was not seen again for nearly six years by which time his condition progressively de-

teriorated. At this time roentgenographic studies of the chest revealed extensive interstitial fibrosis with enlargement of the heart to the left. Skull studies showed a large, irregular "geographic" quadrilateral area of bone destruction in the right parietal region, approximately 8 by 4 cm. in size. The upper right femur also showed cystic areas of rarefaction in the shaft with thickening of the cortex. A biopsy of the lesion in the right parietal bone showed a pattern of granuloma consistent with the diagnosis of Schüller-Christian disease.

While reports of treatment by irradiation of osseous lesions in this disease have been commented on favorably by various authors, accounts of treatment of pulmonary lesions by roentgen radiation are rare. Early treatment when the pulmonary infiltration is predominantly granulomatous may be expected to be of greater effectiveness than that administered when fibrous tissue predominates, a change which is part of the evolution of this disease and one that is likely to render irradiation fruitless.—*Eugene J. McDonald, M.D.*

LINDSKOG, G. E., and BLOOMER, W. E. Bronchogenic carcinoma. *Cancer*, July, 1948, 1, 234-237.

The authors present a statistical comparison of two consecutive series of 100 cases of bronchogenic cancer treated by the surgical service of Yale University. These two groups are studied to determine whether or not changes in the diagnostic and therapeutic picture have occurred during the last decade.

There was a remarkable similarity in the vital statistics, symptomatology, location of primary lesion, and means of obtaining the tissue diagnosis in both series. As regards the treatment, the exploratory-thoracotomy rate has risen only slightly from 32 to 40 per cent indicating the patients are still not visiting their physicians much earlier than before. The percentage of resections has increased from 12 per cent of the total (38 per cent of all explorations) to 21 per cent (or 52 per cent of all explorations). Although this suggests progress, it more accurately reflects an increased willingness to carry out palliative resections in hopeless cases.

The summary of both series shows that in unscreened cases of bronchogenic carcinoma seen in a general hospital more than half (61 per cent) are unsuitable for exploration; that more than half of explored cases (46 per cent)

will be resected, that one in five of the resections (19 per cent) will be a hospital mortality, and that less than 5 per cent of the original group will survive five years.—*J. A. Campbell, M.D.*

AGATE, JOHN N. Delayed pneumonitis in a beryllium worker. *Lancet*, Oct. 2, 1948, 2, 530-533.

This is the history of the first known case of delayed beryllium pneumonitis in the United Kingdom although the author gives a reference listing 60 such cases elsewhere.

The patient was a physicist, aged thirty-six, engaged in lamp research. His significant exposure was between December, 1941, and December, 1942. His first symptoms occurred in November, 1945, three years after his last exposure. The condition was variously diagnosed miliary tuberculosis and sarcoidosis on the chest roentgenogram before the true cause was determined.—*J. S. Summers, M.D.*

DOTTER, CHARLES T., and STEINBERG, ISRAEL. Angiographic study of the pulmonary artery. *J.A.M.A.*, Feb. 26, 1949, 139, 566-572.

Changes in the pulmonary artery occur in both congenital and acquired heart disease as well as in pulmonary and other thoracic disease. Prior to the advent of angiocardiology differential diagnosis has been difficult. By this procedure the living anatomy and pathology can be demonstrated.

This paper presents an angiocardigraphic study of the normal and abnormal pulmonary artery over an eleven year period.

After a detailed description of the normal pulmonary artery, including measurements, the following pathologic conditions are discussed.

(a) Congenital heart disease (the statement is made that an abnormal pulmonary artery is present in every case of congenital "cyanotic heart disease");

1. Congenital aneurysm of pulmonary artery
2. Septal defect, both auricular and ventricular
3. Patent ductus arteriosus
4. Eisenmenger's syndrome
5. Pulmonic stenosis
6. Tetrad of Fallot

All these lesions are compatible with life beyond the first few years. Angiocardigraphic study is indicated in every case of the tetrad of

Fallot prior to surgery in order that surgical measures may be correctly planned.

(b) Acquired heart disease

1. Rheumatic heart disease
2. Syphilis

In all of the conditions listed under (a) and (b) distinctive and pathognomonic appearances are produced by angiocardigraphic study.

(c) Pulmonary heart disease

The end result, cor pulmonale, is the same irrespective of the underlying chronic pulmonary disease among which are emphysema, fibrosis, extensive fibrotic pulmonary tuberculosis, bronchiectasis, silicosis, chronic obstruction of conus arteriosus by aortic aneurysm and primary sclerosis of pulmonary artery.

(d) Secondary abnormalities of pulmonary artery of the nature of displacement or distortion due to mediastinal and hilar masses, kyphoscoliosis, thoracoplasty, pneumothorax, and pneumonectomy.

Angiocardigraphy is indicated in the pre-operative diagnosis of pulmonary and mediastinal tumors. Occasionally changes are demonstrated which indicate inoperability.

This is a well presented and discussed paper, adequately illustrated, which should be read in the original by those interested in this highly specialized field. As soon as a standard technique is established angiocardigraphy should become a routine hospital procedure. The authors make only brief mention of their technique in this discussion. They utilize standard equipment and rely on two chest films produced at predetermined times after the intravenous injection, with an ordinary stereoscopic cassette changer. Many different techniques have been used by others such as photofluorography, cinefluorography and rapid serial study with full sized films and cassettes.—*Frank Huber, M.D.*

NEMEC, STANLEY S. Differential diagnosis of retrocardiac shadows. *Radiology*, Feb., 1948, 50, 174-183.

Variations in density within the cardiac shadow may present characteristic features of diagnostic importance and aid in early detection and proper differentiation and evaluation of asymptomatic retrocardiac lesions. Moderate overpenetration of chest roentgenograms aids in the differential diagnosis of lesions not obvious on routine exposures.

Herniation of the stomach through the

diaphragm may produce a duplication of density within the cardiac silhouette. Barium meal confirms the diagnosis. The author outlines a double contrast method of better visualizing the lower esophagus and stomach in obese patients whose stomach is retrocardiac and difficult to demonstrate. The fasting stomach is first distended with carbon dioxide from cold soda water, and barium then administered, followed by proper fluoroscopic and film examination. The cardio-esophageal junction is often well demonstrated by displacing fundus gas into the lower esophagus by a horizontal or Trendelenburg oblique or left lateral decubitus position, and trapping this gas with an additional barium swallow.

Right-sided widening of the mediastinum, or reduplication of the right cardiac contour, and obliteration of the right cardiophrenic angle, are characteristic of megaesophagus; whereas left-sided widening is produced predominantly by aortic aneurysm, tortuous aorta, and retrocardiac stomach. Large esophageal diverticula, and mediastinal enteric cysts may produce retrocardiac shadows.

Among diseases of the lung producing retrocardiac shadows are atelectasis, bronchogenic cysts, tuberculoma, echinococcus cyst, pneumonia, bronchiectasis, lung abscess, and mediastinal pleural effusion. Vertebral column disease includes tuberculosis of the spine with paravertebral abscess, scoliosis, sympathicoblastoma, fibrosarcoma, and tumors of neurogenic origin. Cardiovascular conditions discussed were aneurysm of the descending aorta, congenital and senescent elongation and tortuosity of the aorta, and left atrial enlargement.—*Richard E. Lukes, M.D.*

GROSS, ROBERT E., and HURWITT, ELLIOTT. Cervicomedial and mediastinal cystic hygromas. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 599-610.

Cystic hygroma of the neck is an uncommon lesion but a well recognized entity. In view of the marked tendency of these cystic masses to involve adjacent structures by direct extension one might anticipate a relatively high incidence of cervicomedial lesions. However, a review of the literature reveals only 19 cases of cervicomedial hygromas while intrathoracic hygromas without involvement of the neck are even more rare. Cystic hygromas are congenital malformations. Characteristically, they are thin-walled cystic structures lined

by endothelium. The authors report 3 cases.

In the tumors with mediastinal involvement the roentgenogram may demonstrate a slightly lobulated, smoothly outlined mass. It is usually not possible by this means alone to distinguish hygromas from other benign tumors or cysts of the mediastinum (such as duplications of the esophagus, bronchial cysts, dermoids, and teratomas, pericardial celomic cysts or tumors of the thymus gland).

The authors recommend treatment of cervicomedial hygromas by (1) separate operations in the neck and thorax, and (2) by excision of the cervical portion and simultaneous sclerosis of the intrathoracic part. However, they call attention to the favorable results reported by Singleton and Goetsch wherein excision of the cervical portion was followed by roentgen therapy to the mediastinum and also the procedure described by Portmann wherein radon seeds were applied to the mediastinal remnants.—*Mary Frances Vastine, M.D.*

SENGPIEL, GENE W., RUZICKA, FRANCIS F., and LODMELL, ELMER A. Lateral intrathoracic meningocele. *Radiology*, April, 1948, 50, 515-520.

The authors point out rarity in that only 3 cases were reported from 1920 to 1946 in which meningocele originated from the lateral aspect of the spine, and report such a condition occurring in a twenty-one year old soldier.

In the reported case the skeletal defect was minimal. The skeletal defect appears to play the role of a necessary concomitant in the development of a meningocele. Embryology of the meninges also plays important part in development of meningocele and same is discussed.

Importance of differential diagnosis of solitary, rounded, well circumscribed lesions appearing in the chest. Importance of a diagnostic pneumothorax is demonstrated. In retrospect usual myelographic procedures would have established the diagnosis and avoided necessity of an operation.—*Robert D. Moreton, M.D.*

ABDOMEN

WHITEHOUSE, FRANCIS R., and KERNOHAN, JAMES W. Myenteric plexus in congenital megacolon. *Arch. Int. Med.*, July, 1948, 82, 75-111.

The myenteric plexus has been studied in 11 cases of congenital megacolon, a series of cases used as controls and 5 cases of secondary megacolon.

The sympathetic nervous system is generally conceded to have an inhibitory action on the colon and thus causes retention of the fecal contents and retards the emptying of the colon. The parasympathetic nervous system has an augmentative action on the colon that causes evacuation of the fecal contents and accelerates the emptying of the colon. The internal anal sphincter will relax after parasympathetic stimuli and undergo an increase in tone after sympathetic stimuli. With such a physiologic basis, it has been postulated that the cause of the fecal retention in cases of megacolon is an overactivity of the sympathetic nervous system in the presence of a normally active parasympathetic nervous system.

The myenteric plexus was found to be absent in the most distal part of the colon in all cases of congenital megacolon. In 80 per cent of the cases it was absent also in the "transitional region." In 60 per cent of the cases it was in addition absent in the lower part of the sigmoid. In 20 per cent of the cases the absence of the myenteric plexus extended from the rectum into the upper part of the sigmoid and the descending colon. In all cases of congenital megacolon there were nerves present in the location of the myenteric plexus which were not seen in the control cases.—*Eugene J. McDonald, M.D.*

CULVER, GORDON J., and KLINE, J. RICHARD. Acute gaseous cholecystitis. *Radiology*, April, 1948, 50, 536-538.

Three good figures demonstrating three of McCorkle and Fong's four criteria for roentgen diagnosis of gaseous cholecystitis, namely, non-visualization of the duct system, a gallbladder of normal size, and gas in the gallbladder wall.

This patient had severe non-radiating right upper quadrant pain, jaundice, fever and laboratory evidence of gallbladder obstruction. Responded favorably to penicillin and sulfadiazine. The authors advocate conservative treatment and believe even interval cholecystectomy is contraindicated.—*E. E. Seedorf, M.D.*

JANUS, WILLIAM L. Regional jejunitis. *Radiology*, April, 1948, 50, 532-535.

The author reveals that only 18 examples of regional enteritis of the upper small bowel had appeared in the literature until 1939. He asks the question whether the condition is rare or merely unrecognized. He presents 3 cases of regional jejunitis of which 2 were diagnosed

preoperatively by roentgen examination.

In early stages irritability and hypermotility of the involved portions of the bowel are characteristically present. Suspected areas must be observed fluoroscopically and studied with spot films in addition to routine progress films. A chest film is essential to complete the diagnosis in all suspected cases of regional jejunitis since it may be simulated by tuberculosis. Sprue and vitamin deficiency states must also be considered in the presence of a disturbed small bowel pattern.

The author emphasizes fact that regional enteritis is not necessarily limited to the ileum, nor must it involve the ileum and proceed toward the stomach.—*Robert D. Moreton, M.D.*

FELDMAN, MAURICE. Statistical study of life cycle of 1,154 cases of duodenal ulcer. *J.A.M.A.*, March 13, 1948, 136, 736-738.

The causes of peptic ulceration remain a debatable question. The role of acid still seems predominant in the etiology of this condition. The importance of psychogenic influences is fairly well established, but the exact mechanism which it plays in the etiology of peptic ulcer is not definitely known. Recent studies on vagotomy have stimulated considerable interest in this condition and emphasized the neurogenic influence in peptic ulcer.

This study involving 7,300 gastrointestinal examinations was made on an unselected group of ambulatory private patients of both sexes and all ages presenting digestive disturbances. These cases were divided into two five year periods: (1) prewar, 1937 to 1941 (3,500 cases), and (2) during and immediately after World War II, 1942 to 1946 (3,800 cases). An appraisal of the data collected over a ten year period, with two separate psychological periods, should give some statistical evidence regarding the cycle of peptic ulcer and materially add to our knowledge. During this ten year period, 1,154 cases of duodenal ulcer were found, an incidence of 15.87 per cent. In the five prewar years there were 480 cases, or 13.7 per cent. In the second five years, during and immediately following the war, there were 674 cases of duodenal ulceration, an incidence of 17.7 per cent.

The following information is revealed by this study: 1. A rising trend in the incidence of duodenal ulcer during and immediately after World War II amounted to about 4 per cent. 2. The comparison of the age and sex incidence in duodenal ulcers between the prewar and the

war period showed no significant statistical change. 3. There was a slight increase in the incidence of cases of less than one year duration in the second five year period. 4. According to the objective roentgen findings for the determination of the activity of the ulcer, there seemed to be an increase in the second five year study. 5. There was slight increase in the number of niches observed roentgenologically in the wartime cases. A slight increase was noted in the number of niches occurring in females in the war group. 6. There was a higher incidence of first recurrences and an increase in the incidence of "acute" ulcers during the war period. 7. In many instances the severity of symptoms seemed to be more pronounced during the war period, because of the increased number of acute ulcers. 8. The complications, obstructions and hemorrhages were not statistically different in the two groups of cases. There was a greater incidence of hematemesis in females during the war period.—*C.W. Williams, M.D.*

RAFSKY, HENRY A., WEINGARTEN, MICHAEL, and KRIEGER, CHARLES I. Onset of peptic ulcer in the aged. *J.A.M.A.*, March 13, 1948, 136, 739-741.

From 1,800 consecutive admissions for gastric ulcer, the authors have selected 81 cases (4.5 per cent), which represent those with initial ulcer symptoms occurring after the fifth decade of life. Of these, 60 patients were male, and 21 were female. Forty-seven of the group presented complications on admission, the main symptom of which was hemorrhage, with 3 being associated with perforation. Of the uncomplicated cases, the outstanding symptom was pain. Attention is called to the difficulty in differentiating benign and malignant lesions in this age group with symptoms of short duration. Gastroscopic examination is advised whenever feasible. Treatment employed was mainly medical, with only 19 of the group being treated surgically. Of these, 11 had perforation, 6 of which died. The mortality rate in this group of patients was 16 per cent (11 patients). The authors feel that gastric ulcer in the aged is not infrequent, and that complicating diseases play a very important role in the prognosis.—*C. Sory, M.D.*

WALTERS, WALTMAN, NEIBLING, HAROLD A., BRADLEY, WILLIAM F., SMALL, JOHN T., and WILSON, JAMES W. Results of vagus nerve

resections in treatment of peptic ulcer. *J.A.M.A.*, March 13, 1948, 136, 742-747.

The cases in this report are divided into two series all of which were performed at the Mayo Clinic:

Series I (Performed by the Authors).

Vagotomy Alone: Vagotomy alone was done in 10 patients with duodenal ulcer, in 2 with gastrojejunal ulcer, and in 5 with gastric ulcer. All obtained relief of the pain caused by ulcer. Three of the 10 patients with duodenal ulcer, and 1 of the 5 with gastric ulcer had disturbances of motility. Four of the patients with duodenal ulcer were reported at dismissal as still having visible ulcers on roentgenologic examination. Vagotomy with a simultaneous gastric operation was done in 24 patients with duodenal ulcer, in 5 with gastrojejunal, and in 4 with gastric ulcer. In 23 of the 24 patients with duodenal ulcer, all 5 with gastrojejunal ulcer, and in 2 of the 4 patients with gastric ulcer, relief of distress from the ulcer was obtained. Ulceration recurred in 1 patient with gastric ulcer in whom subtotal gastrectomy was necessary six months later, and in another the gastric ulcer failed to heal. Both had pronounced reductions of gastric acidity and repeatedly negative reactions to the insulin test after vagotomy. Six of the 24 patients with duodenal ulcer who had associated gastroenterostomy, 2 of 5 with gastrojejunal ulcer, and 3 of 4 patients with gastric ulcer all had moderate to marked disturbances of motility.

Series II (Colleagues' Cases).

Duodenal Ulcer: There were 8 cases having vagotomy only, 5 of these were done transthoracically, and 3 abdominally. Of the 5 done by the transthoracic approach, 4 had good results, although 2 had some retention of food and fluid postoperatively. The fifth patient complained of gas, and occasional episodes of diarrhea eight months after operation. Of the 3 who underwent vagotomy abdominally, 1 was well at dismissal. Another had intermittent vomiting and diarrhea three months after surgery, and the third died postoperatively apparently from pulmonary embolism.

Vagotomy and gastroenterostomy were done in 25 patients with duodenal ulcer. Twenty-four had relief of the symptoms of ulcer. Eighteen of these 24 had no disturbances of motility. Six patients had disturbances of motility

characterized by epigastric fullness, nausea and diarrhea. The 25th patient died on the fourteenth postoperative day from perforated duodenal ulcer and subdiaphragmatic abscess.

Vagotomy and Pyloroplasty: There were 4 patients in this group. All obtained relief of distress from ulcer. Two had disturbances of motility of consequence six and ten months postoperatively.

Gastrojejunal Ulcer: There were 30 cases in this group but in 3, the operation was performed too recently to permit evaluation. Of the 27 cases, 15 were done transthoracically and 12 abdominally. Of the 15 done transthoracically, 9 had good results from vagotomy with absence of all symptoms of ulcer. Three patients had unsatisfactory results with recurrence of the symptoms of ulcer. Of 7 done abdominally, the existing anastomosis was not disturbed. Of these, 3 had obtained good results clinically when dismissed. Three still complained of minor degrees of fullness and diarrhea several months after operation. The remaining patient noticed gas and dizziness when hungry which was relieved by frequent small meals. The remaining 5 had good results.

Gastric Ulcer: There was 1 patient in this group. Along with vagotomy, the ulcer was excised and pyloroplasty done simultaneously. Early relief of symptoms was obtained with a reduction in acidity.—*C. W. Williams, M.D.*

MARSHALL, SAMUEL F., and WELCH, MARK L.

Results of surgical treatment for gastric ulcer. *J.A.M.A.*, March 13, 1948, 136, 748-751.

Gastric ulcer presents a serious problem in its treatment because of possible malignant changes arising in a benign ulcer and especially because of the considerable percentage of diagnostic errors made in distinguishing between benign and malignant ulceration of the stomach.

At the Lahey Clinic, from 1936 to 1945, inclusive, in those cases in which a preoperative diagnosis of benign gastric ulcer had been made, partial resection was carried out on 131 patients. The histopathologic examination of the removed lesions disclosed carcinoma in 26 of the 131 cases, a diagnostic error of 19.8 per cent in the cases in which operation was done. During this same ten year period approximately 8,000 patients with peptic ulcer were treated. Of this number, 800 had gastric ulcers. In the entire group of 800 cases treated medically and surgically, there were 26 proved malign-

nant gastric ulcerations, an incidence of proved malignancy of 3.3 per cent for the entire group. This is assuming that none of the patients treated medically proved later to have cancer, a most unlikely possibility. All of this group of 131 cases were, however, ultimately submitted to operation by the gastroenterologist because of failure to heal, and because, therefore, gastric cancer could not definitely be ruled out. Seventeen of this group of 26 proved malignancies had been treated one month or longer before decision to operate was made. This trial period of observation over a month is considered to be too long. Decision regarding necessity of surgical intervention should be made much earlier.

The results following adequate partial gastrectomy for benign gastric ulcer (105 cases in this series), are excellent. Eighty-six per cent of the patients had absence of free hydrochloric acid after operation. There were no postoperative recurrent ulcers and no obstruction occurred in any case at the gastrojejunal stoma. No attempt should be made to treat any patient with gastric ulceration by resection of the vagus nerves because of the difficulty in determining whether an ulcer is benign or malignant. This can be determined definitely only by pathologic section.

Most patients within a few weeks or months after the operation can eat an ordinary, full diet with few restrictions and with no gastric distress. All are relieved of ulcer distress and pain, and all are able to work usually within three months after operation.

There were three deaths following resection, an operative mortality of 2.8 per cent, in the group of 105 cases with benign gastric ulcer. Two deaths were due to pulmonary embolism, and one followed coronary occlusion.—*C. W. Williams, M.D.*

THOMPSON, HAROLD L. Complications of peptic ulcer. *J.A.M.A.*, March 13, 1948, 136, 752-761.

The author lists as primary complications of peptic ulcer: (1) perforation, (2) hemorrhage, (3) obstruction, (4) intractability, and (5) malignant degeneration. This paper is concerned with the first three.

Pyloric obstruction may be associated with the acute phase of a duodenal ulcer, resulting from edema and spasm, and is considered a medical problem, responding to routine medical management. If the obstruction results from

cicatricial formation, surgery is employed. Differentiation is mainly clinical. Surgical treatment advised is subtotal gastrectomy. Vagotomy with gastrojejunostomy seems to give good results, but at the present time may well be limited to treatment associated with acute ulcers.

Hemorrhage from peptic ulcers is a common complication, and the choice of medical or surgical treatment should be made through consultation with a competent internist and surgeon. Emergency surgery should be considered only in cases of acute hemorrhage and of a relatively severe nature. The age of the patient with a bleeding peptic ulcer is considered an important deciding factor, and the author suggests a trial of medical treatment for those under forty-five years of age, and favors the surgical approach for those over forty-five years. Those in the upper age group are more likely to have other complicating diseases which do not lend themselves favorably to systemic effects resulting from hemorrhage. If surgery is anticipated, it is advised within the first forty-eight hours.

Perforation of a peptic ulcer is considered as an acute surgical emergency, with the mortality rate increasing with increase in time between perforation and surgery. Increase in the amount of food in the stomach at the time of perforation also increases the mortality rate. The author favors closure of the perforation, cleaning the peritoneal cavity, and closure of the abdominal wound without drains. He points out that in his experience the mortality rate is increased in direct proportion to the number of drains used. He feels that gastric resection should be reserved as a second stage procedure, if needed, and when the patient is in better condition.—*C. Sory, M.D.*

ST. JOHN, FORDYCE B., HARVEY, HAROLD D., FERRER, JOSE M., and SENGSTAKEN, R. W. Results following subtotal gastrectomy for duodenal and gastric ulcer. *Ann. Surg.*, July, 1948, 128, 3-14.

In an analytical review of 394 partial gastric resections for peptic ulcers the authors make the following points: (1) There has been a high percentage of excellent results with the patients returning to a normal life. Recurrences have been infrequent. (2) For individuals under forty-five years the mortality has been about 1 per cent. (3) In the older age group, if there is any suspicion of carcinoma at all, resection

should be carried out. In cases of bleeding duodenal ulcer in the older patients the lower mortality of vagus resection is appealing. However, follow-ups on these cases have not been long enough for adequate evaluation. (4) Psychic factors have not appeared to seriously interfere with the benefits of surgery. Many patients have lost their psychoneurotic tendencies when free of pain or bleeding. (5) There has been a steady improvement in the post-operative mortality at the Presbyterian Hospital, New York City, in the past thirty years dropping from 20 per cent in 1916-1925 to 2.5 per cent for the years 1946-1947.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

MOORE, GEORGE E., STATE, DAVID, HEBBEL, ROBERT, and TRELOAR, ALAN E. Carcinoma of the stomach; the validity of basing prognosis upon Borrmann typing or the presence of metastases. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 513-518.

An analysis, according to Borrmann's classification, of the relative influences of regional metastases and the gross anatomic types of gastric carcinoma on postoperative survival is presented in this paper.

Schindler has recently offered evidence that the prognosis and perhaps the advisability of any therapeutic procedure for carcinoma of the stomach may be based upon the Borrmann type of the tumor. Borrmann separated the gastric carcinomas into 4 gross types: I, sharply demarcated polypoid carcinomas; II, sharply demarcated ulcerated carcinomas; III, partly infiltrating carcinomas; IV, diffusely infiltrating carcinomas. Combining Types I and II as "limited" and Types III and IV as "infiltrative" groups, Schindler noted that there was a much higher resectability rate and lower mortality rate for the former group. On the basis of his data, Schindler questioned the advisability of resection of infiltrative tumors.

The authors point out that survival is dependent on complete removal of the tumor and the likelihood of such removal should, in the case of the stomach, just as for other organs, be to a degree reflected in the presence or absence of regional metastases. Consequently, they have compared the effects of the gross anatomic types of carcinoma and regional metastases upon the survival rates.

Conclusions.

1. The presence or absence of demonstrable

metastases in regional nodes among the patients subjected to gastric resection for carcinoma has a greater prognostic value than does the Borrmann type of the tumor.

2. The Borrmann type affects the prognosis of groups of cases to the extent that the limited tumors provide a proportionately large number of patients free of metastases while the infiltrating tumors which are more numerous are more likely to have metastasized.

3. The presence or absence of metastases cannot be accurately determined preoperatively and no patient should be denied operation because of the type of tumor he may be diagnosed as having.—*Mary Frances Vastine, M.D.*

BEYNON, A. E. Primary carcinoma of the liver in a boy aged 15. *Lancet*, Oct. 2, 1948, 2, 528-530.

This is an unusual case first detected because of metastatic tumor seen in the lung fields on a mass survey. The case is of interest because of the lack of symptoms and the maintenance of body weight for a year after the tumor was first discovered. There was but slight increase in the size of the lung lesions.

The diagnosis was definitely made by aspiration biopsy. The boy died after sixteen months of observation. There was never any evidence of icterus. Necropsy was refused.—*J. S. Summers, M.D.*

NICKELL, DAVID F., and DOCKERTY, MALCOLM B. The five year survival rate in cases of completely obstructing annular carcinoma of the descending colon and sigmoid; pathologic study. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 519-524.

The five year survival rate in 37 cases of completely obstructing annular carcinoma of the descending colon and sigmoid in which resection was performed is compared with the five year survival rate in cases in which non-obstructing lesions had been treated surgically. These rates were 25.7 per cent and 51.7 per cent respectively.

1. The five factors which may contribute to the lowered five year survival rate are: (1) damage to the intestinal wall with increased permeability and increased lymphatic absorption; (2) hypertrophy of the musculature which produces a massaging and traumatizing action to the carcinoma at the site of obstruction; (3) inflammatory swelling and edema which cause breakdown of any mechanical protective

factor, and of any protective forces elaborated the host; (4) the invasive property of the cancer cell, whether it be motility or some lytic action, which is facilitated by the effect of the factors just mentioned, and (5) the ileocecal valve which may produce a closed-loop type of obstruction.

2. The size of the lesion is of no significance in prognosticating the presence of metastasis and the volume of malignant tissue is actually less in the cases of obstruction than in the cases in which no obstruction was present.

3. No correlation was found between the grade of the lesion and the incidence and degree of obstruction or between the duration of obstruction in days and the survival rate.

The authors point out that this is a small series of cases on which to base any definitive conclusions but with the strict criteria for obstruction used, namely, complete obstruction requiring a colostomy or cecostomy for decompression before removal of the lesion, the series would of necessity have to be small. Notwithstanding, they believe that such a difference in the five year survival rate in cases of obstructing and nonobstructing carcinoma of the descending colon and sigmoid, 26 per cent in this series, is significant. This difference is not due to a difference in the grade of malignancy of obstructing carcinomas but rather apparently to the condition of the intestinal wall attending the complication of obstruction.

—*Mary Frances Vastine, M.D.*

BLACK, WILLIAM A., and WAUGH, JOHN M. The intramural extension of carcinoma of the descending colon, sigmoid and rectosigmoid; pathologic study. *Surg., Gynec. & Obst.*, Oct., 1948, 87, 457-464.

The present-day approach to the cure of carcinoma of the colon is surgical extirpation of the primary lesion and all its extensions with restoration of continuity of the bowel and preservation of sphincteric control whenever feasible.

The importance of carcinoma of the colon is attested by its incidence and cause of death in the general population. The mortality statistics of the Bureau of Census for 1936 give the total death rate from all causes as 1,151.8 per 100,000 population. Of these deaths, cancer and other malignant tumors cause 111 per 100,000. Of the deaths due to cancer, cancer of the intestines except the duodenum, rectum, and anus accounted for 12 per 100,000 population. Since

less than 3 per cent of carcinomas of the intestines originate in the small bowel, the figure for cancer of the intestines represents essentially that for carcinoma of the colon, exclusive of the rectum and anus.

Conclusions.

1. In carcinoma of the colon, the raised edge of the lesion may not mark the limit of intramural extension.

2. There is no appreciable difference in intramural spread of carcinoma above or below the lesion.

3. Intramural spread of carcinoma is greater in the descending colon than in other sites in the left portion of the colon.

4. The plane of greatest extension in the bowel wall is the submucosa.

5. The grade of malignancy (Broders' method) of the lesion has no relation to the degree of intramural spread.

6. Spread of carcinoma through the bowel wall appears to follow the course of the intramural lymphatics.

7. Spread of carcinoma to the extramural lymphatics occurs before the entire bowel wall is penetrated.

8. For resections of the left part of the colon for carcinoma, only 2 centimeters of normal bowel need be allowed above and below the lesion in order to remove the whole of the primary lesion.—*Mary Frances Vastine, M.D.*

GENITOURINARY SYSTEM

HENLINE, ROY B., and HAWES, CECIL J. Ureteropelvic obstructions; symptoms and treatment. *J.A.M.A.*, June 26, 1948, 137, 777-784.

Gastrointestinal symptoms may be the first or sole manifestation of an obstructive renal syndrome. Due to the common nerve supply of the kidney and gastrointestinal tract the symptoms of indigestion, nausea and flatulence may result from kidney disease even though renal symptoms are absent and urinary studies are normal. In this report of 52 patients with ureteropelvic obstruction, the presenting complaints in 20 were of a gastrointestinal nature. Renal pain, such as backache and colic, was present in 46 cases and urinary symptoms in 22. It is interesting to note that in 19 patients the voided urine was normal.

The most common cause of ureteropelvic obstruction is intrinsic stenosis due to stricture, to hypertrophy of the circular muscle and valves

or to the presence of fibrous tissue. In 62 kidneys which were operated upon, 71 per cent showed obstruction caused entirely by intrinsic disease, while extrinsic factors alone, such as aberrant vessels, bands and adhesions were present in 3.2 per cent. A combination of intrinsic and extrinsic factors was observed in 25.8 per cent. The importance of these findings cannot be overestimated inasmuch as the correction of an obvious external cause such as separation of vessels or bands results in failure of the operation if intrinsic pathology is overlooked.

Although excretory urography frequently demonstrates ureteropelvic obstruction it is the practice of the authors to rely only on the ten minute delayed roentgenogram following retrograde pyelography to make the diagnosis. Dilatation of the internal structure of the kidney and retention of dye are observed.

Formerly, partial ureteropelvic obstruction with accompanying hydronephrosis was treated by nephrectomy. With increasing knowledge of the etiologic factors, improvement in surgical technique and the use of antiseptics and antibiotics, plastic operations now result in the preservation of renal tissue.

In the treatment of ureteropelvic obstruction the authors prefer the Foley Y plastic operation, employing a nephrostomy tube for drainage and a soft rubber splinting catheter passed halfway down the ureter. The catheters are left in place for six weeks. By this method of treatment there were no operative deaths and relief of symptoms was obtained in 87.2 per cent of the patients.—*Gerald Lawner, M.D.*

IRVIN, G. E., and KRAUS, JOHN E. Congenital megaloureter and hydroureter; pathogenesis and classification. *Arch. Path.*, June, 1948, 45, 752-765.

After briefly reviewing the history of the subject and citing the various etiological theories previously advanced, the authors conclude that there are three basic types. True megaloureter represents hyperplasia of all elements of the ureteral wall without evidence of obstruction or neurologic defect, resulting in a thickened tortuous ureter with a nearly normal lumen. This may be associated, as in their case, with megalobladder and hydronephrosis. A second type is a simple dilatation from organic obstruction or neurologic defect. Third, they distinguish an intermediate type: secondary dilatation of a true megaloureter, of which they present 2

cases, both with megalobladder and hydronephrosis.

The authors emphasize the view that true megaloureter is probably a congenital structural anomaly rather than the result of disturbed ureteral physiology.—*D. D. Beiler, M.D. and C. L. Hinkel, M.D.*

HERBST, WILLIAM P. The posteriorly located renal pelvis associated with ptosis. *J.A.M.A.*, June 26, 1948, 137, 775-777.

In the author's experience, patients with ptosis of the kidney and with symptoms severe enough to warrant surgical treatment, all showed the renal pelvis coming from a scooped-out-like depression on the posterior aspect of the kidney. The diagnosis of posteriorly located renal pelvis was made in 25 patients, of whom 19 were operated on. This abnormality is the result of fusion between the ureteral bud and metanephros posteriorly, rather than of an anomaly of rotation of the kidney. The roentgenographic signs are inconstant but the diagnosis is suggested in the anteroposterior projection by (1) the appearance of a gun barrel effect in the ureteropelvic region, (2) the location of the ureter lateral to the medial pelvic border, and (3) in the lateral and oblique projections by visualization of the ureter arising posteriorly. The treatment of the posteriorly placed urinary pelvis associated with ptosis is nephropexy, primary nephrectomy, or resection of the lower pole of the kidney with removal of the overhanging mass of renal tissue.—*Gerald Lawner, M.D.*

ABOWITZ, JACOB. Obstructive hydronephrosis produced by aberrant blood vessels and diagnosed by intravenous urography. *Radiology*, Jan., 1947, 48, 33-36.

This article is a brief general discussion of the subject of ureteral obstruction by anomalous blood vessels which supply the kidney. The author properly indicates the important place of excretory pyelography in the diagnosis of this condition.

The roentgen findings may be divided into three general classifications: The first represents the caliceal and pelvic dilatation due to the obstructive uropathy and include the evidence, as indicated in the erect film, that the upper urinary tract does not empty its contents properly. The second group of roentgenographic findings are those due to the defect produced in the ureter by the aberrant vessel or by the fibrot-

ic bands which represent atresia of an aberrant vessel. These findings on the urogram are described by the author as a sharp line of decreased density, indicating the site of the constriction produced by the aberrant vessels.

A third group of roentgen findings may be considered as the advanced hydronephroses usually associated with an extrarenal type of pelvis in which the cause of the obstruction is obliterated by the marked dilatation of the renal pelvis and by the consequent hydronephrosis and atrophy of the kidney.—*George W. Chamberlin, M.D.*

RUDHE, ULF. A typical roentgen picture of very large ureterocele. *Acta radiol.*, 1948, 29, 396-402.

During the years of 1946 and 1947 three cases of very large ureterocele have been observed at the roentgen diagnostic department of the Caroline Hospital. The diagnosis in each case was confirmed at cystoscopy or operation. As the roentgen picture in such cases appears to be little known, the cases are described in detail.

These ureterocele appear as large, rounded, distinctly outlined soft tissue formations which cause corresponding defects in the bladder contrast. In 2 of the cases the picture resembled that of prostatic hypertrophy. Two of the cases showed the distal ends of the ureters to be angulated in the shape of a hook with the ureteral orifices elevated. This appearance has also been described as typical of prostatic hypertrophy. There were no signs of trabeculation in the bladder wall. (In cases of prostatic hypertrophy of this size the wall is usually trabeculated because of the chronic obstruction to emptying.) In ureterocele, this same trabeculation may occur. The ureterocele, if large, may reach the internal vesicle orifice and act as a valve over the bladder outlet.

Anomalies such as double renal pelves and ureters are rather common in cases of ureterocele. In the 3 cases reported completely duplicated renal pelves and ureters were found on the same side as the ureterocele. The ureterocele involved the ureters belonging to the upper pelves. Stenosis at the intravesical ureteral orifice brought about dilatation of the ureter and upper renal pelvis resulting in loss of function in the kidney parenchyma.

In conclusion, the author emphasizes that the ureterocele in cases with coexisting complete reduplication of renal pelvis and ureters,

as a rule, seem to affect the ureter from the upper pelvis.—*Mary Frances Vastine, M.D.*

PERRY, S. PAUL, and HADEN, W. DAN. Accidental filling of urinary tract during barium enema. *Radiology*, April, 1948, 50, 539-540.

A case report in which the complete urinary tract became visualized with barium during routine fluoroscopic examination of the colon.

Several years previously the patient had a perforated sigmoid diverticulum; then a recto-vaginal fistula developed and recently the patient had been passing feces and gas when urinating.

Patient experienced no ill results. A subsequent intravenous pyelogram was normal.—*E. E. Seedorf, M.D.*

NERVOUS SYSTEM

BRIERLEY, J. B., and FIELD, E. J. The connexions of the spinal sub-arachnoid space with the lymphatic system. *J. Anat.*, July, 1948, 82, 153-166.

The authors, after reviewing the literature, present their techniques for studying the sub-arachnoid connections in adult rabbits, using india ink as an indicator. They present their observations and discussions in a comprehensive manner. They have demonstrated that under conditions as nearly physiological as possible, ink particles not over 1.5 microns can pass readily from the subarachnoid space into cervical and prevertebral lymph nodes. These latter may be regarded as the regional lymph nodes of the subarachnoid space. Their studies show that ink introduced into the subarachnoid space appears in the nasal mucosa and cervical lymph nodes within four hours. Ink introduced into the cranial subarachnoid space can be found as low as the mid-thoracic level at the end of one hour and throughout the spinal subarachnoid space in six hours. Concentration of ink is marked around the lumbosacral nerve roots and in the terminal part of the spinal subarachnoid sac. Lymph nodes around the aortic bifurcation and in the hollow of the sacrum show ink filling in six hours. Repeated ink injection produces filling of the lymph nodes arranged along the front of the thoracic and lumbar vertebrae in a more or less "segmental" manner. The pathway of the outflow is discussed.—*H. G. Reineke, M.D.*

NAFFZIGER, H. C., and BOLDREY, E. B. Cancer of the nervous system; brain spinal cord and

peripheral nerves. *J.A.M.A.*, Jan. 10, 1948, 136, 96-103.

Tumors of the nervous system constitute 2 per cent of all cancers. Gliomas constitute 50 per cent of all intracranial tumors and must be regarded as malignant. Astrocytomas are the most common glioma and these types are recognized: fibrous, which carries the best prognosis; protoplasmic, a diffuse type which is fairly responsive to roentgen therapy; and gemistocytic, which is usually rapidly fatal. Second most common of the gliomas is glioblastoma multiforme, the sudden onset of which may lead to an erroneous diagnosis of a vascular accident. Combined surgery and roentgen therapy may give survival rates as long as five years after the first diagnosis. Medulloblastoma, the commonest glioma of childhood should never be regarded as being completely removed by surgery, and since the cells are radiosensitive, judicious use of roentgen therapy following surgery is the treatment of choice. Survival up to five years is not uncommon. Ependymoma constitutes about 10 per cent of all gliomas and is fairly resistant to roentgen therapy. Polar spongioblastoma constitutes about 5 per cent of all gliomas, is most often seen in the region of the pons, optic chiasm and corpus callosum, which fact usually makes this tumor not amenable to surgery. It is moderately susceptible to roentgen therapy and patients have been carried along successfully for several years by its judicious use. Oligodendroglioma constitutes about 5 per cent of all gliomas, is relatively indolent and but moderately responsive to roentgen therapy.

Meningiomas constitute about 16 per cent of brain tumors. They usually arise from the arachnoid, and are frequently associated with increase in vascular supply which may be manifest in plain roentgen films of the skull. Usually, they are resistant to roentgen therapy.

Cerebellopontine angle tumor (acoustic neuroma) constitutes about 10 per cent of intracranial neoplasms. They may be bilateral and are sometimes associated with von Recklinghausen's disease.

Pituitary tumors constitute about 5 per cent of all intracranial tumors. Chromophobe, eosinophilic and basophilic adenomas are discussed briefly. The authors favor, in general, attempted surgical removal prior to roentgen therapy, if visual acuity is threatened.

Tumors of the hypophysial duct, epidermoid

and dermoid cysts, angiomas and hemangioblastomas are discussed briefly. The latter is susceptible to roentgen therapy to a moderate degree.

Intracranial granulomas are also mentioned since they may produce symptoms indistinguishable from neoplastic growths.

A brief discussion of the signs and symptoms of neoplasm of the spinal cord is presented with the statement that 50 per cent are completely removable with anticipation of a good result if surgery is done prior to irreparable damage to the cord. The tumors which are discussed very briefly are extramedullary tumors, meningioma, perineural fibroblastoma, gliomas (include all the types mentioned in the discussion of intracranial gliomas), angioma, epidermoid cysts, intrinsic tumors of the vertebrae exerting pressure on the cord by direct extension and intervertebral disc.

Tumors of the peripheral nerves are almost always tumors of the nerve sheath, such as perineural fibroblastoma (which usually can be enucleated), neurofibromas and neurofibrosarcomas. Tumors of the neuronal element are exceedingly rare. The ganglioneuromas, seen usually in infants and childhood, are encapsulated and if completely removed, do not tend to recur. But the rare neuroepithelioma is highly malignant and requires radical treatment.—*M. M. Manalan, M.D.*

SKELETAL SYSTEM

MESCHEN, ISADORE, and McGAW, W. H. Newer methods of pneumoarthrography of the knee with an evaluation of the procedure in 315 cases. *Radiology*, Dec., 1947, 49, 675-711.

The authors have presented an analysis of their experience with 782 pneumoarthrograms of the knee performed between April, 1942 and April, 1945. The examination is believed to be without risk and is now done routinely in all cases of suspected internal derangement.

Technique.

Oxygen Insufflation: 80-120 cc. of oxygen is injected through a needle inserted into the joint space along the lateral aspect of the knee just below the junction of the quadriceps tendon with the superior articular margin of the patella. This is done under strict asepsis. After the injection the patient is turned to the prone position and the knee flexed and massaged gently

for a few minutes to circulate the oxygen evenly through the joint.

Roentgenological Examination: It is important that the tibial plateau is perpendicular to the film and that the central ray goes through the joint space. A mechanical device is described which facilitates widening the lateral and medial aspects of the joint. Five views are usually obtained: (1) anteroposterior with spreading of the medial side of the joint; (2) anteroposterior with spreading of the lateral side of the joint; (3) posteroanterior with spreading of the medial side of the joint; (4) posteroanterior with spreading of the lateral side of the joint; (5) a straight lateral with the knee partially flexed. If these views do not give sufficient information, excellent visualization can be obtained by turning the knee on one side or the other and allowing it to rest on a block which acts as a fulcrum when it is spread. The roentgenograms are then taken by a horizontal beam.

The Normal Pneumoarthrograms: The suprapatellar bursa, the infrapatellar fat pad, the medial meniscus (semilunar cartilage), the lateral meniscus and the popliteal bursa can be clearly delineated. The other structure which can be detected fairly well, but not sufficiently accurately for diagnosis are: the synovial reflection over the popliteus muscle; the crucial ligaments; the articular cartilages covering the femoral condyles; the tibial condyles and the patella; the posterior septum. The presence of fluid in the joint space may interfere. It is best to remove as much as possible or wait for its absorption before performing the examination. There is a complete description of the normal and abnormal variations which have been observed.

The analysis of the results is divided into two periods. In the first between April, 1942 and April, 1944, 528 air injections were done and there were 230 arthrotomies. In the second period from April, 1944 to April, 1945, 254 air injections were done and 85 arthrotomies performed. Because of experience in interpretation and improvement in techniques the accuracy of diagnosis rose from 64.8 per cent in the first period to 81.6 per cent in the second period. Of equal importance is the fact that with experience the number of unsatisfactory examinations decreased from 14.5 per cent to 2.3 per cent. The mistaken diagnoses only fell from 20.7 per cent to 16.1 per cent. It is stressed that the improvement in the accuracy of diagnosis was due

to a lessening of the errors of omission rather than of commission.

Abnormalities of the lateral meniscus and medial meniscus are found in a ratio of 2 to 5 and together amount to two-thirds of the major lesions in internal derangement of the knee joint. The other lesions found are abnormal fat pads in somewhat less than one-third of the cases. As a rule, fat pad abnormalities are secondary to some other pathologic process in the joint.

About 25 per cent of the patients had osteochondritis dissecans or chondrosis of the patella. This frequency is one-half that of the medial meniscus lesions and 5 per cent greater than lateral meniscus lesions. Twenty-five per cent of the cases with osteochondritis or chondrosis had loose bodies in the joint; in about half there were other pathologic changes such as fractured menisci.

Popliteal bursae or cysts were present in 13.5 per cent of the cases and are probably without pathological significance unless associated with inflammatory changes or if the communication with the joint is interfered with. Cornu fractures of a meniscus are very difficult to diagnose and may escape detection.

In the present stage of development, the pneumoarthrogram is 80 per cent accurate. The authors believe that the clinical examination at best is approximately 70 per cent accurate. In the case of the pneumoarthrogram, the type and completeness of the lesion can be more accurately predicted. This is especially valuable when both the medial and lateral menisci are involved in the same knee.

The air study and the clinical examination are frequently complementary and permit a greater accuracy when employed together. With both studies an accuracy of diagnosis in the neighborhood of 90 per cent should be achieved.
—Norman Heilbrun, M.D.

JACOBS, LEWIS G. Isolated fracture of the pisiform bone. *Radiology*, April, 1948, 50, 529-531.

There are only 18 examples of isolated pisiform fracture on record. Incidence estimated not to exceed 1 case in 100 fractures of carpal bones exclusively. Dislocation of pisiform reported with about the same frequency.

Author describes position for proper roentgenogram and discusses mechanism for cause of fracture.

Clinical history of author's patient is briefly described. Roentgenograms of the fractured pisiform are presented.—*E. E. Seedorf, M.D.*

COLES, WILLIAM C., and SCHULTZ, MILFORD D.
Bone involvement in malignant lymphoma.
Radiology, April, 1948, 50, 458-462.

Review of 288 histopathologically proved cases of malignant lymphoma to determine the percentage having bone involvement and determine what influence such involvement may have on the course of the disease or well-being of the patient.

Determination of bone involvement was made by roentgenograms and postmortem examination. Thirty-eight, or 13 per cent, of the 288 patients had manifest involvement of bone at time of first observation or sometime later in the course of the disease. Giant follicular lymphoma was found to involve the skeletal system in a disproportionally low degree while reticulum cell sarcoma revealed skeletal involvement in a rather high degree.

Fifteen patients had solitary involvement and in all there were 113 separate areas of bone involvement in the 38 patients. The spine is the most frequently affected.

Age range of patients was from seven to eighty-three years and ratio of male to female patients, 1.3 to 1. No significant age or sex predilection for bone involvement in malignant lymphoma was found.

With exception of solitary osseous involvement by reticulum cell sarcoma where the object is to try to cure, the attitude in treatment of bone lesions has been essentially that entertained in treatment of malignant lymphoma in general, that is, an attempt at palliation, the intent being to relieve symptoms as they appear. The amount of radiation varies from 600 to 1,500 r.

With the exception of solitary reticulum cell sarcoma of bone, which may be a curable disease, the appearance of bone involvement seems to have no noticeable effect on the survival rate. Neither does the time of appearance of the bone lesion, whether early or late in the course of the disease affect appreciably the ultimate prognosis, except in widespread reticulum cell sarcoma when it tends to occur terminally.—*Robert D. Moreton, M.D.*

PLATT, JOSEPH L., and EISENBERG, RICHARD B.
Eosinophilic granuloma of bone; report of

six cases. *J. Bone & Joint Surg.*, July, 1948, 30-A, 761-768.

In this paper 5 cases of eosinophilic granuloma of bone are summarized. A sixth case is presented in more detail as it illustrates the benign nature of the lesion and the results of conservative treatment.

Laboratory studies, although not complete in every case, were not helpful in making a diagnosis. The authors believe the actual diagnosis rests upon histopathological study. In the discussion of therapeutics, the strong tendency to healing of the lesion is emphasized. This is apparent in view of the uniformly good results following a variety of therapeutic measures. Beneficial results were obtained from roentgen therapy. The roentgen technique used varied for the 6 cases, in some cases 200 kv. was employed, in others 135 kv. The dosage at each treatment varied from 50 to 200 r, the time interval being daily doses or on alternate days. The total dosage ranged from 300 r to 900 r. Wide surgical excision, which was carried out in one case, now seems to the authors not justified. Their experience as carried out in this case, together with the information gained from an analysis of the reported cases, suggests that surgery in suspected cases of eosinophilic granuloma of bone might well be limited to that necessary to secure an adequate biopsy or to relieve local pressure in skull lesions, and that, after the diagnosis has been established, this should be followed by radiation treatment of all the lesions.—*R. S. Bromer, M. D.*

BABAŁANTZ, LÉON. Les ostéopathies atrophiques. (Atrophic osteopathies.) *J. de radiol. et d'électrol.*, No. 7-8, 1948, 29, 333-362.

In these 29 pages every aspect of atrophic osteopathies is discussed and the thoroughness of the review leaves nothing to be desired. The English Summary at the close of the article is quoted in full:

"The author studies atrophic osteopathies (A.O.), for the most part metabolic, in the light of the latest scientific acquirements in histo-biochemistry and radiologic morphology.

"Knowledge of physiopathic conditions and histogenetic mechanisms is essential for the understanding and distinguishing of the various kinds of osteopathies, especially as regards their relation with phosphocalcic or proteic metabolism disturbances, and with other endogenous and exogenous factors.

"Bone decalcification must be of some im-

portance—about 50 per cent—to be visible on the X-ray film, as the author has shown in his experiments with chemically decalcified bones.

"Statement of the radiological semiology of A. O. Classification of osteopathies according to their clinical particularities in 8 groups with statement of the histogenetic mechanisms and the essential biochemical data particular to each group. 1. Senile osteoporosis; 2. Deficiency osteopathies; 3. Hormonal osteopathies; 4. Splanchnic osteopathies; 5. Toxic osteopathies; 6. Myelogenic osteopathies; 7. 'Thésaurismoses'; 8. Idiopathic osteopathies.

"The radiological finding of a bony atrophy often reveals an unknown disturbance of protein or mineral metabolism. This must be looked out for. Morphological diagnosis of A.O. by X-rays is only possible in a limited number of bone dystrophies showing a typical radiological picture. Generally only a bone biopsy can offer certainty. Etiology, as a basis for a rational treatment, will be established by anamnestic, radioclinical and biochemical data."—*William M. Loehr, M.D.*

MARQUES, P., GRIMAUD, M., and POUCH, G. La dégénérescence maligne des tumeurs a myélopaxes. (Malignant degeneration of giant cell tumors of bone.) *J. de radiol. et d'électrol.*, No. 3-4, 1948, 29, 116-119.

Five cases of malignant changes occurring in giant cell tumor of bone are reported and the authors discuss the present ideas concerning such changes in benign giant cell tumor. As for the possibility of therapy being a cause of malignant change in these tumors, the authors state that one should not forget that in the majority of cases these same therapeutic measures bring about healing and one cannot, therefore, ascribe to therapy the sole factor of cancerization. The authors insist on the possibility of malignant degeneration of giant cell tumors of bone. This transformation (quite rare) cannot be foreseen in any particular case. At the most, certain forms showing rapid progress and development can only be suspected of malignant potentialities and treated as a malignant tumor whether by surgery or radiation therapy.—*William M. Loehr, M.D.*

SHERMAN, ROBERT S., and PEARSON, T. ARTHUR. The roentgenographic appearance of renal cancer metastasis in bone. *Cancer*, July, 1948, 1, 276-285.

A study of 36 proved cases of renal metas-

tases in bone with adequate roentgenographic coverage was made to determine if these lesions might present characteristics to differentiate them from any other form of skeletal carcinomatous metastases. No correlation between the cell type and the roentgenographic appearance of the metastases was evident.

In no instance was the original roentgenographic diagnosis of renal cancer metastases made on the basis of the roentgenographic appearances alone. Eighteen cases were diagnosed as metastases, however. Four cases were called osteogenic sarcoma, and in one, an amputation was done for the mistaken diagnosis of primary bone tumor. The high percentage of solitary metastases of slow growth enhances this difficulty.

Twenty-one of the 36 cases were solitary. In 15 instances where two or more tumors were seen, the appearance of the lesions was fundamentally alike. No significant site of predilection to certain bones was evident. In 34 of the 36 cases, the medulla was thought to be the site of origin. Some of the tumors showed an early tendency to extend outward beyond the bone into the soft parts. It seems that an oval shape is the more characteristic of renal bone metastasis. Destruction of bone was a constant finding, yet productive changes of a lesser degree were found in 16 cases. Periosteal reaction was seen in 5 instances; cortical destruction with the formation of a periosteous mass was common. Pathological fractures occurred in half of the cases.

Analysis of the roentgenographic picture indicates three types of renal metastases: the lytic, the septate, and the patchy. The lytic was most common (27 cases); the septate was found in 6 cases; and the patchy in 3 cases. There is some tendency toward septa formation in the lytic type especially following roentgen therapy. Recognition of the septate form roentgenographically offers the possibility of diagnosing these lesions as cancer metastases of renal origin.—*J. A. Campbell, M.D.*

BICKEL, WILLIAM H., YOUNG, H. HERMAN, PFUETZE, KARL H., and NORLEY, THEODORE. Streptomycin in tuberculosis of bone and joint. *J.A.M.A.*, June 19, 1948, 137, 682-687.

Sixteen patients with tuberculosis of bones or joints were treated using streptomycin in addition to the usual treatment in such conditions.

The authors believe 1 gm. of streptomycin each day given intramuscularly every eight to

twelve hours to be the optimal dose. This is continued for 90 to 120 days.

In this series of cases the treatment with streptomycin varied between 66 days and 190 days with an average duration of 112 days. The average total dose of streptomycin was 134 gm. The daily intramuscular dose of streptomycin varied from 0.75 to 2 gm.

Mild to moderate toxic symptoms were found in 9 of the 16 patients. One patient required discontinuation of the drug. This patient, as well as the others, was desensitized and the drug was continued as previously planned.

A detailed report is given of each case. Response to streptomycin was considered favorable in 9 cases and fair in 1 case; there was no benefit in 4 cases, and the therapy was too recent to evaluate in 2 cases.—*V. L. Peterson, M.D.*

JAFFE, HENRY L., and LICHTENSTEIN, LOUIS.
Chondromyxoid fibroma of bone. *Arch. Path.*, April, 1948, 45, 541-551.

The authors present a series of 8 cases of a rare and peculiar benign connective tissue tumor of bone which they feel must be regarded as a pathological entity. The tumor is characterized pathologically by a mixture of chondroid and myxoid elements and clinically by slow evolution and a benign course. The danger is that it may be misdiagnosed a sarcoma and thus overtreated.

There is no particular age or sex predilection. All of the eight tumors were in the femur, tibia or some bone of the foot. Those in the femur and tibia were in the metaphyses adjacent to the knee, eccentrically placed, eroding the cortex but never piercing the periosteum. There is often a local palpable bulge. They were often bounded inwardly by a zone of sclerosed bone and outwardly by a thin shell of subperiosteal bone. The article includes several roentgenographic illustrations of these features. Among lesions which may be confused with these tumors are bone cysts, enchondromas and foci of fibrous dysplasia.

Treatment has been by curettage, and none have recurred as yet (1½ to 7 year follow-up in 6 cases).—*D. D. Beiler, M.D., and C. L. Hinkel, M.D.*

TOONE, ELAM C., JR. Rheumatoid spondylitis: Observations on the incidence and response to therapy among veterans of the recent war. *Ann. Int. Med.*, April, 1949, 30, 733-739.

This report deals with a series of 29 cases of

rheumatoid spondylitis. During the period under consideration there were 8,937 admissions to the hospital as a whole and 197 admissions to the wards set aside for the care of arthritic patients. Rheumatoid spondylitis is a disease of unknown etiology capable of producing severe crippling deformities and is particularly prone to affect otherwise healthy young males. Information from reports indicate that its incidence is increasing. Precipitating factors such as trauma, exposure, infection and climatic conditions are variable and inconstant, and knowledge about the cause and pathogenesis of the disease is inadequate. Roentgen therapy is a valuable means of controlling pain and relieving muscle spasm, but must be combined with measures of a general supportive nature and with measures designed to prevent or correct deformities.

Pain is the universal complaint of patients with rheumatoid spondylitis and so was found to be the major complaint in each of the patients of this series. At the onset the pain is usually localized in the lower back, is often sharp and stabbing in character, intermittent in occurrence and tending to be more severe at night. The average weight loss in this group was 18 pounds with variation from no loss to a loss of 46 pounds. Discouragement, frustration, and severe mental depression were frequently encountered. Almost all of the patients felt discouraged and confused by previous varied diagnoses and inappropriate and ineffective management. Only 2 patients had previously received roentgen therapy.

Roentgenographic changes are probably the most valuable single finding in the diagnosis of rheumatoid spondylitis. The sacroiliac joints are the most important joints to be examined and will almost always show a bilateral involvement if the disease is present. This may vary from an early narrowing of the joint space with irregular bone proliferation and osteoporosis of the adjacent bone to complete ankylosis. Each of the 29 cases in this series showed bilateral involvement of these joints. The apophyseal joints are more difficult to visualize and special oblique views are necessary to demonstrate any change. Here again changes vary from narrowing of the joint space to complete ankylosis. Calcification of the anterior and lateral ligaments and of the ligamentum flavum is a common finding and may appear relatively early in the disease. Fifteen cases showed evidence of calcification in one or more of these ligaments.

Treatments are given at biweekly intervals for two weeks until each area selected for treatment has received 600 r and the patient is allowed a rest interval of from six to eight weeks and the course is repeated. The average patient receives a total of three courses in this manner and then further treatment is withheld for six months unless a relapse occurs. At the end of six months the patient returns for re-evaluation and treatment is repeated or withheld according to his response. The mode of action of roentgen rays in relieving pain in rheumatoid spondylitis is not understood, but apparently its greatest beneficial effect results from its ability to lessen muscle spasm.—*Eugene J. McDonald, M.D.*

WERTHEIMER, LUIZ GUSTAVO. Coracoclavicular joint; surgical treatment of a painful syndrome caused by an anomalous joint. *J. Bone & Joint Surg.*, July, 1948, 30-A, 570-578.

In the normal human skeleton, the bones of the shoulder girdle are joined together by the acromioclavicular articulation and by the trapezoid and conoid ligaments, which go from the inferior surface of the lateral third of the clavicle to the body of the coracoid process. These coracoclavicular ligaments help to unite the clavicle and scapula and, with their form and elasticity, they allow a certain degree of dislocation between these bones in movements that have as centers the acromioclavicular and sternoclavicular articulations. Occasionally however, there is found an articular formation which joins the two bones of the scapular girdle, substituting for the trapezoid and conoid ligaments the "artculus coracoclavicularis."

Comparatively few cases of this condition have been reported in the literature. The known total to date is 50 cases. In one reported case, a woman who had fractured the surgical necks of both humeri and who had bilateral coracoclavicular joints, the articulations were regarded as predisposing factors in the production of the fractures. Some writers have attributed pain and limitation of shoulder movements to these anomalous joints. In another case a painful cervicobrachial syndrome improved after resection of a coracoclavicular joint.

The author's patient was a Negro, male, aged thirty-seven, who complained of pain in the shoulder for the last three years before admission to the hospital. The pain, following a comparatively slight trauma, was continuous, radiating to the arm, and increased with exercise

and persisted during rest. The roentgenograms of the shoulder showed no local alteration, except for an anomalous coracoclavicular joint; a bony projection, 1 cm. long, arose from the site of union of the middle and lateral thirds of the clavicle and was directed downward and outward. It was slightly enlarged at its free end which was directed downward and inward. At the base of the coracoid process was a formation directed toward the clavicular process, with its free surface adjusted exactly, and from which it was separated by a space of 3 mm. Roentgenograms of the opposite side showed no similar anomaly. Operation was performed, resection of the coracoclavicular joint, following which the patient improved. Three months after operation he was free from pain, movements were not restricted, and it was possible for him to join his hands over his head with his arm fully extended.

The author states the essential point is to demonstrate the existence of an articulation, whether it be a diarthrosis, a symphysis or another type of joint. Schlyvitch, quoted by the author, stated roentgenograms are open to question and that a true articulation can only be shown by dissection. Other authors have asserted that the presence of a clavicular bony process with a facet adapted to the adjacent coracoid process, like the articular surfaces of other true articulations and with a clear articular fissure, leaves no doubt as to the existence of other elements, such as an articular capsule, which cannot be demonstrated in a roentgenogram.

In his first case, no other cause of pain could be found and only the anomalous joint could be held responsible. It is possible that this joint hindered the free motion of the shoulder, especially when the patient's work involved heavy labor. It is questionable whether, as in some reported cases, osteoarthritis of the shoulder may later develop. His second case was a chance discovery of the anomalous joint in a patient suffering from thoracic contusion. There were no complaints that could be attributed to its presence. The roentgenogram showed the abnormal articulation but not as well developed as in his first patient.—*R. S. Bromer, M.D.*

ARKIN, ALVIN M., and SCHEIN, ALBERT J. Aseptic necrosis in Gaucher's disease. *J. Bone & Joint Surg.*, July, 1948, 30-A, 631-641.

In a previous paper, the authors described and attempted to classify hip-joint changes in

Gaucher's disease. Apart from the statement that changes in the femoral head in children resemble those of Legg-Perthes disease, and that the ultimate changes in the hip-joint in adults might be of degenerative origin and might be secondary to these childhood lesions, no attempt was made to interpret the pathological-physiological background for these changes. Subsequently, in one patient treated by prolonged relief from weight-bearing, almost complete restitution of the femoral head took place. At about the same time, cases of Gaucher's disease in adults were encountered, which markedly resembled cases of caisson disease, at least with regard to the bone changes. In addition, in one of their adult cases, roentgenograms taken during childhood indicated that the condition actually had begun, as they had hypothesized, in childhood as a Legg-Perthes-like condition. They present this paper for the purpose of drawing together these various observations, as they are related to the occurrence of a pattern which suggests that aseptic necrosis of bone is a significant factor in Gaucher's disease of bone.

Phemister discussed the known and unknown causes of aseptic necrosis in the femoral head. He included the lesions of traumatic origin, such as fractures and dislocations involving the known blood supply of the injured parts, and non-traumatic lesions, such as caisson disease, arteriosclerosis, osteochondritis dissecans of the hip in adults, and Legg-Perthes disease. He did not mention Gaucher's disease except to state that he had seen collapse of the femoral head with osteo-arthritis of the hip in Gaucher's disease, which resembled idiopathic osteochondritis dissecans of the hip in adults.

Six cases are reported with roentgenographic studies. The first case, first seen when the patient, a girl, was ten years old, is the only case report Arkin and Schein could find in which reconstitution to a state approximating normal, roentgenographically and clinically, occurred in a case of Gaucher's disease involving the femoral head and hip-joint, while the patient was under observation. Presumably, this fortunate outcome was due, as is true in Legg-Perthes disease, to protection from weight-bearing while the necrotic-appearing, reorganized bone and cartilage of the involved joint were still in the plastic stage. They state it remains to be seen whether further changes during late adolescence and adult life will ensue, including hypertrophic osteoarthritis. In the second case,

in an older patient previously reported, roentgenograms have lately been found in the library of the X-ray Department which are the original roentgenograms taken during adolescence showing an earlier condition of the hip joint which resembles the infiltrative, Legg-Perthes-like progress seen in the first case. In the third case, a male aged thirty-nine, the changes in the hips suggest the end stages of advanced aseptic necrosis of both femoral heads. In the fourth case, a male, aged fifty, the changes in the hip resemble those found in caisson disease but a routine sternal bone marrow puncture showed the basic nature of the condition was Gaucher's disease. In the fifth case, roentgenograms of the left femur showed typical changes of Gaucher's disease. In the upper portion of the left tibia, a mild sclerosing lesion of bone was present in the metaphyseal region, reminiscent of absorbing caisson disease or aseptic infarction of bone. The same type of lesion was found in the sixth case.

In their discussion of the pathogenesis of the disease, the authors believe that the most likely explanation of their findings is that Gaucher cells, which are known to surround and infiltrate small arteries and capillaries, at times sufficiently cut off circulation to produce aseptic necrosis of bone. Roentgenographically and clinically, the course parallels that of aseptic necrosis of other etiology in which the pathology has been confirmed.—R. S. Bromer, M.D.

HOWORTH, M. BECKETT. Coxa plana. *J. Bone & Joint Surg.*, July, 1948, 30-A, 601-620.

The basis of this report is a study of 115 cases of coxa plana, seen in various stages of the disease, during the ten years from 1933 to 1944 inclusive. In it, the clinical features, the etiology, pathological findings, stages of the disease, laboratory findings, roentgenographic features, differential diagnosis and treatment are discussed.

Howorth does not regard the name coxa plana as altogether satisfactory, but it is the best name so far suggested. The condition is also known as Legg-Perthes disease or Calve's osteochondritis deformans juvenilis, and aseptic necrosis of the upper femoral epiphysis. He believes the term aseptic necrosis is not accurate for describing either the pathological or roentgenographic features of the disease, and should be discarded. Coxa plana, he states, is one of a group of diseases, the osteochondroses, which include slipping of the upper femoral

epiphysis, coxa magna, Osgood-Schlatter disease, apophysitis of the calcaneus, Köhler's disease, Freiberg's disease, Kienböck's disease and epiphysitis of the spine (Scheuermann's disease). They are all characterized by degenerative changes, due to circulatory disturbance, but occur at various ages in various epiphyses or small bones. The age differences of the osteochondroses are explained by the varying vulnerability of the local circulation at different ages. Degenerative changes similar to those of coxa plana may be produced, however, by circulatory damage at other ages, for example, after slipping of the upper femoral epiphysis or fracture of the femoral neck.

The pathological changes in coxa plana were studied at operation in 50 cases. They are summarized as follows: *Early Stage*: synovial membrane swollen, edematous; lymphocytic infiltration, especially about the blood vessels; scattered plasma cells and mononuclear wandering cells (histiocytes); degeneration of hyaline cartilage of the epiphyseal plate; fibrocartilaginous repair at junction of plate with neck; irregular architecture of bony trabeculae of capital epiphysis. *Late Changes*: synovial membrane thickened, avascular, and sclerotic; capsule thickened and contracted.

The first evidence of the disease in the roentgenograms is a globular swelling of the capsule. The joint space appears wider medially, because of a slight lateral subluxation. It appears wider superiorly, because of a flattening of the ossified portion of the epiphysis; but there is no change in the shape of the articular cartilage at this stage.

Soon after the onset, the epiphyseal line appears wider and is irregularly decalcified at its junction with the neck. An irregular dense area soon appears in the capital epiphysis, usually in the central portion. Gradually the dense area becomes irregularly decalcified, but it may enlarge at the same time. During the decalcification, the head becomes wider, flatter and thinner, and the neck becomes thicker and shorter. Gradually the soft tissue swelling subsides. The epiphyseal line recalcifies, while the proximal surface of the neck becomes convex and grows into the head. More gradually the decalcified areas are recalcified. Eventually normal trabeculation occurs, but the head retains its mushroom shape and tends to remain subluxated. The shape of the acetabulum usually follows somewhat the shape of the head. Osteo-arthritic changes often develop in middle

life, but these are usually not so severe as those found in cases with slipping of the upper femoral epiphysis, probably because of greater mechanical and physiological disturbance later in life.

Degenerative changes, similar to those in coxa plana, often occur in the course of treatment of congenital dislocation of the hip, slipping of the upper femoral epiphysis, or fracture of the neck of the femur. These changes are due to interference with the circulation to the head, either by "wringing out" of the blood vessels along the neck by immobilization in full extension often with abduction and internal rotation, or by separation of the head from the neck in the course of treatment. Similar degenerative changes occur in suppurative arthritis of the hip due to inflammatory and mechanical pressure interference with circulation to the femoral head.

Coxa plana runs a self-limited course over a period of years and always heals. There is always a residual deformity. The head and neck are broad, the head is flattened and shallow and the acetabulum is somewhat flattened and shallow to correspond to the head. Treatment has little effect on the course of the disease. Bed rest is the treatment of choice in the incipient or acute and rapidly progressive phases of the disease. The hip should be kept slightly flexed for relaxation of the soft tissues and improvement in circulation. The best ambulatory treatment is the suspension of the extremity from a sling and belt with the use of crutches. This should be continued while there is pain and spasm and while the head is soft. The drilling operation, when done skillfully and gently, with a minimum of damage to the circulation, results in more rapid healing of the lesion with less deformity, but the period of healing is still much too long.—R. S. Bromer, M.D.

GHORMLEY, RALPH K., and CLEGG, REED S. Bone and joint changes in hemophilia; with report of cases of so-called hemophilic pseudotumor. *J. Bone & Joint Surg.*, July, 1948, 30-A, 589-600.

The changes seen in the joints of persons affected by hemophilia are familiar to members of the medical profession. In addition, changes may be seen in the shafts of the long bones in some cases of hemophilia. Such changes are seen much less frequently than are the joint changes and, in the experience of the authors

of this paper, are more severe and result in disaster in most instances. In their series of 44 patients in whom pathological changes developed in the bones and joints, all were males. Six patients were included in the series, 5 of whom are known to have hemophilia; 1 had some type of blood dyscrasia or hemorrhagic diathesis which was never positively diagnosed. The extensive changes found in the joints are familiar to those interested in hemophilia, but their experience has led them to believe that the bone changes, such as those seen in these cases, are much less frequent and are less familiar to all interested in the disease than are the changes in the joints. One of the 6 cases had involvement of the phalanges of the thumb, 1 with involvement of the olecranon and 4 with involvement of the femur. In all cases the most nearly adjacent joint was involved to some extent, and reasonable doubt may exist as to whether the bone changes were secondary to hemorrhages within the joint or whether they were due to primary hemorrhages within the bone or in the subperiosteal tissue adjacent to the bone.

The 6 cases are reported in detail with roentgenograms illustrating the bone lesions. The case with involvement of the phalanges of the thumb showed in the roentgenogram a large tumor-like shadow with destruction of the terminal phalanx. In the cases involving the femur there were varying amounts of destruction of the cortex and in the case involving the olecranon a cyst-like area was present in the olecranon process. Of the 4 patients with involvement of the femur, all are now dead.

Müller, who reported the results of roentgen therapy in 2 cases, is quoted by the authors. He arrived at the conclusion that irradiation had influenced the resorption of the tumor primarily by changing the reaction of the reticulo-endothelial system, as well as by influencing the products of cell destruction. Others have maintained that the roentgen rays influence the constitution of the blood. In the one patient of the authors' series who was treated by roentgen therapy, no improvement was noted.

From the study of the cases reported, Ghormley and Clegg believe it reasonable to conclude that these pseudotumors may arise (1) from hemorrhages originating in the joint, extending along the bone to produce erosion; (2) from subperiosteal hemorrhages which may lead at first to formation of new bone and later to

absorption and destruction of bone, and (3) from cortical or medullary hemorrhage, which may lead to cystic changes and later may destroy the bone or lead to fracture and further hemorrhage. It is difficult to state accurately in any one case which route was followed. On the other hand, it seems important to be able to recognize the condition early enough so that destructive changes may be kept under control.—R. S. Bromer, M.D.

HORWITZ, THOMAS. Bone and cartilage debris in the synovial membrane; its significance in the early diagnosis of neuro-arthropathy. *J. Bone & Joint Surg.*, July, 1948 30-A, 579-588.

This paper is devoted to the significance of the anatomical finding of bone and cartilage debris (detritus) in the synovial membrane as a possible indicator of the early evolutionary stage of a neuropathy of a joint, notably in cases in which the clinical and roentgenographic findings, at least as far as the joints are concerned, are still those of an osteoarthritis. Attention is paid specifically to 5 cases with involvement of the knee joint. In 3 of these, the diagnosis of neuro-arthropathy was first suggested by the results of histopathological examination of excised synovial membrane. In the other 2, while there was some clinical evidence in favor of neuro-arthropathy, the diagnosis was substantiated by the pathological findings.

Horwitz concludes that the observation of bone and cartilage debris ground into the synovial membrane appears to have diagnostic value in the early evolutionary stages of neuro-arthropathy in cases wherein the clinical and roentgenographic features are equivocal, being still those of an osteoarthritis. It has been a constant finding in the pathological material from all patients with neuropathic joints. Furthermore, the amount of bone and cartilage detritus appeared proportionate to the degree of disruption of the remaining components of the affected joint, and to the stage of evolution of the neuro-arthropathy and of its underlying neurological disease. However, he found that in a control group of 30 cases with operable lesions of the knee joint, it was also found in the material from 2 cases of advanced degenerative arthritis of the knee joint without a neurogenic basis. Therefore, he observes that the presence of imbedded debris, while highly

suggestive, is not altogether specific in the neuro-arthropathies.

The pathogenesis appears to be based on the formation of debris through the erosion of articular cartilage and subchondral bone, which has become ground into the articular soft tissues by continued weight-bearing on a joint less sensitive than a normal joint.—*R. S. Bromer, M.D.*

GRANT, FRANCIS C.; AUSTIN, GEORGE; FRIEDENBER, ZACHARY, and HANSEN, ALTON. A correlation of neurologic, orthopedic and roentgenographic findings in displaced intervertebral discs. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 561-568.

The purpose of this paper is to present a group of postoperative disc patients who have been critically studied neurologically and orthopedically. The results of these examinations were then integrated with the roentgen findings. In this way the authors hoped to determine any relationship that might exist between the preoperative and postoperative roentgenograms, the operative findings, and the eventual operative result. The summary of their findings follows:

1. A group of 95 postoperative disc patients was studied.
2. Sixty per cent of these patients were regarded as cured and were able to pursue a normal full day's work without any back or sciatic pain.
3. Eighty-seven per cent of these patients were fully satisfied with the results of the operation.
4. The factors of age, trauma, or type of occupation appear to have no relationship to this type of injury. Also the type of operation appeared to be unrelated to the result.
5. Air myelograms while helpful were not as accurate as desired in the author's experience. Oil myelography, preferably with pantopaque as the contrast medium, is the method of choice and should be routinely employed.
6. The end-results will be more gratifying in proportion to the degree of displacement of the nucleus pulposus.
7. Lost or diminished achilles reflexes do not often return, nor should a patient be allowed to believe paralysis will invari-

ably recover following successful removal of the offending mass.

8. No relationship between increased narrowing of an intervertebral space and clinical result can be shown. Fusion of the vertebral bodies or dense bridging occurred in 6 patients, all of whom are in the group of clinically well. It could be postulated that more will develop this change as time goes on, but further follow-up studies will be necessary to substantiate or disprove this point.
9. It seems unlikely that the presence of a significant quantity of residual opaque oil in the caudal sac has any influence upon the clinical result.
10. The fundamental principle for good results is careful selection of patients with exclusion of those cases that fail to measure up to an exacting history and physical examination supported by myelography.—*Mary Frances Vastine, M.D.*

BARTELINK, D. L. Myelography in intervertebral disc protrusion; horizontal beam examination with the patient prone. *Radiology*, Feb., 1948, 50, 202-206.

A narrow dural sac and lateral protrusion of the intervertebral disc are not the only reasons for failure of operatively proved disc hernias to produce a characteristic defect in the contrast oil column. The author demonstrates some anatomic reasons for certain shortcomings of conventional vertical beam myelography, and describes a method of eliminating some possible false negative diagnoses of lumbar intervertebral disc protrusion. The prone patient is examined on a special narrow tilt table placed between the table and screen of the vertical fluoroscope, using maximum milliamperage, high kilovoltage, and a fine grid.

The dural sac was not found in direct contact with the posterior surfaces of the vertebral bodies and discs in 15 per cent of cases, this epidural space varying from 2 to 10 mm. in depth, and being greatest at the lumbosacral disc level. Hence, in these cases an intervertebral hernia cannot reach the dural sac and produce a defect in the opaque column unless the size of the protrusion be considerable. However, the herniated disc may compress the nerve root passing over it and produce a root sleeve defect in the myelogram in the

absence of defect in the contrast oil column.

Concavity of the posterior surfaces of the vertebral bodies, and bony productive changes at the posterior margins of the vertebral bodies may occur, with or without true disc protrusion, and produce narrowing or even separation of the opaque column as seen on the conventional vertical beam myelogram. By use of horizontal beam myelography, the true disc protrusion is apparent as a definite defect in the ventral surface of the column at the disc level, whereas no such defect is seen when only vertebral anatomic variations exist without concomitant disc protrusion.

The horizontal beam prone examination is also useful when faulty injection results in the deposit of opaque medium both intradural and extradural. On lateral fluoroscopy the intradural deposit is seen ventral to the epidural deposit, and can be adequately used for diagnostic myelographic examination.—*Richard E. Lukes, M.D.*

ALBERTENGO, JUAN B. Diagnóstico y tratamiento de la hernia del disco intervertebral (lumbar). (Diagnosis and treatment of lumbar intervertebral disc hernia.) *An. de cir.*, June, 1948, 13, 63-110.

The author presents a detailed study, quoting 134 references, of the entire problem of the herniated lumbar disc. There is discussion of the history of the problem, anatomy, physiology, pathology, symptomatology, clinical history, physical and neurological examination, localization of the lesion, and differential diagnosis. Stress is laid on the importance of evanescence of the symptoms, and their aggravation by coughing and sneezing.

Among supplementary examinations are listed plain roentgenography and myelography. The indications for myelography are discussed, the author believing that myelography is only necessary in atypical and confusing cases, that in the majority of cases correlation of significant changes in the plain films with history and physical findings is sufficient for accurate diagnosis. Present-day myelographic technique is discussed in detail.

There is a long discussion of indications for surgery and of the surgical treatment and the author presents synopses of a series of 10 patients treated by himself, showing varying findings in plain roentgenography and myelography. In a footnote, the author states that

he has operated an additional 12 patients successfully.—*William S. Wallace, M.D.*

GURI, J. PUIG. Tumors of the vertebral column. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 583-598.

Abnormalities in the density, structure or general configuration of the vertebral bodies or neural arches may be produced either by tumors arising primarily in the vertebral column or surrounding structures or as a consequence of metastasis from neoplasm located in other parts of the body. In order to obtain a better understanding of these neoplasms the author studied all the patients with tumors of the vertebral column seen at the State University of Iowa Hospitals with good clinical and roentgenographical follow-up.

Hemangioma. Vertebral hemangiomas are found in 10-11 per cent of autopsies. Hemangioma of the cervical vertebrae is a rarity since this condition usually involves the dorsal or lumbar vertebrae. The author reports a case in which the cervical portion of the spine is involved. Roentgen therapy is the treatment of choice unless there are signs of cord compression.

Giant Cell Tumor. These tumors may be osteolytic or osteoblastic. The author presents 2 cases in which the lesion was osteolytic and involved a sacral segment. When these tumors involve only the neural arches or when involvement of the vertebral body is only partial, removal with curettage is probably the treatment of choice. When the tumor involves most of a vertebral body roentgen therapy is indicated. Spontaneous cures may occur following pathological fracture.

Chordoma. Notochordal tissue remnants are found during postmortem examinations in 2 per cent of cases. They usually appear at the base of the skull or in the sacrococcygeal region. On the roentgenogram an area of rarefaction without signs of new bone formation is the usual picture. A soft tissue shadow may also be seen. Total resection is the accepted treatment since these tumors are radioresistant.

Chondroma. Benign cartilaginous tumors arising from the neural arches are frequent while chondromas arising from the vertebral bodies are rare. The prognosis of chondromas is not dependent upon the histopathological picture but upon their localization. When these tumors are localized at the neural arches and grow posteriorly they may reach enormous sizes

without producing serious complications. Treatment is total resection if possible.

Fibrosarcoma. Seven cases of fibrosarcoma were studied. In these 7 the lesion was purely osteolytic. Fullness or presence of a mass in the paravertebral region or on rectal examination was present in 4 cases.

Chondrosarcoma. In the one case studied the chondrosarcoma was localized in the dorsal spine.

Osteogenic sarcoma. In the one case seen by the writer, the tumor was found to involve, the fourth, fifth and sixth cervical vertebrae.

Hodgkin's Disease. In the 4 cases seen the process involved the vertebral bodies and the transverse processes and was osteolytic in character.

Multiple Myeloma. The roentgenographic findings varied from a marked osteoporosis without definite destructive areas to the characteristic multiple and well circumscribed osteolytic lesions.

Solitary Myeloma. Among the 10 cases of multiple myeloma studied by the author there were 2 cases in which the lesion could be considered circumscribed to the spine during the early stages of the disease. In some of the cases of vertebral solitary myeloma reported in the literature, the lesions remained confined to the spine for periods of ten years.

Vertebral Destructions Produced by Metastasis from Primary Tumors Elsewhere in the Body.

1. Carcinoma of the breast.
2. Carcinoma of the prostate.
3. Hypernephroma.
4. Ewing's tumor.
5. Chondrosarcoma.
6. Bronchogenic carcinoma.
7. Carcinoma of the skin.
8. Carcinoma and fibrosarcoma of the cervix.
9. Osteogenic sarcoma.

Vertebral changes from Tumors Arising in the Vertebral Canal. The author found 2 such cases in his material, one a meningioma and the other a perineurial fibroma.—*Mary Frances Vastine, M.D.*

BRAY, ERNEST A., MOLTER, HOWARD A., and NEWCOMB, WENDELL J. The lumbosacral articulation; roentgenologic and clinical study with special reference to narrow disc and lower lumbar displacement. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 549-559.

In view of the continued difference of opinion relating to the importance of narrowed fifth lumbar disc and displaced fifth lumbar vertebra in the etiology of backache and sciatic pain, a study of a large series of roentgenograms was made with the purpose of establishing the incidence of these conditions.

1. In a series of 500 roentgenograms focused over the lumbosacral joint, narrowed fifth lumbar disc was noted in 26.4 per cent, posterior displacement of the fifth lumbar vertebra was present in 10.2 per cent, anterior displacement of the fifth lumbar was present in 5.0 per cent, and there was displacement of the fourth vertebra in 3.0 per cent.

2. The incidence of back and leg pain in the 181 cases in which these changes were noted was not significantly greater than in the other 319 cases.

3. When the two groups were studied clinically they showed a strikingly similar incidence of alteration in leg reflexes, limitation of straight leg raising, and body tilt on forward bending.

4. The clinical diagnoses in the two groups were almost identical. There was, however, a considerably higher incidence of lumbosacral arthritis in the patients with narrow disc or lower lumbar displacement.

5. A study of the groups of patients with back pain alone, with associated leg pain, and with neither of these complaints revealed no significant difference in the incidence of narrowed fifth lumbar disc. However, there was a smaller incidence of lower lumbar displacement in the symptom-free group.

6. Posterior displacement of the fifth lumbar vertebra is apparently a definite entity and is not due entirely to difference in anteroposterior diameters of the fifth lumbar vertebra and the sacrum. However, in about 20 per cent this is apparently the reason for the appearance on the roentgenogram. It is possible that in cases of posterior displacement, there is secondary atrophy of the anterior edge of the sacrum which decreased the anteroposterior diameter of the first sacral segment.

7. Anterior displacement of the fifth lumbar vertebra is usually associated with a defect in the interarticular portion of this vertebra and in at least 40 per cent of the cases there is anterior lipping of the sacrum.

8. In cases of herniated nucleus pulposus or posterior disc protrusion, the incidence of narrowed fifth lumbar disc or lower lumbar displacement is not significantly greater than in

the remainder of the series. Narrow disc on the roentgenogram cannot be considered clinical evidence of posterior displacement.

9. Narrowed fifth lumbar disc and displacement of the lower lumbar vertebrae are clinically significant only in that these conditions place additional strain on an already mechanically vulnerable lumbosacral joint.

10. The weight of evidence seems to indicate that in most instances narrow fifth lumbar disc and lower lumbar displacement are in themselves not the cause of low back and sciatic pain.—*Mary Frances Fastine, M.D.*

RIKER, WILLIAM, and POTTS, WILLIS J. Sacrococcygeal teratomata in infancy; report of six cases. *Ann. Surg.*, July, 1948, 128, 89-100.

The authors found an incidence of 1 per cent for sacrococcygeal teratoma of all tumors seen by them in pediatric practice. All 6 of their cases were in females and of those reported in the literature 75 per cent were female. A large percentage are still born or die at birth. All of these cases were less than a year old. The exact etiology is unknown but the two main theories are: (1) the teratoma represents a rudimentary organ mass of an ill developed pygopus twin, or (2) the tumor arises from cells already in the sacrococcygeal region and its growth includes nervous, intestinal, bony and connective tissue elements. The tumor mass is quite variable in size, usually lobulated with cystic and solid areas containing tissue of any structure in the body. Roentgen examination proves the presence of teeth and malformed bone.

In the differential diagnosis, meningocele can be differentiated from teratoma in that it does not increase in size with the growth of the infant and is covered by a translucent membrane which bulges on crying or coughing. The presence of spina bifida also suggests meningocele. In a review of the literature the authors found a 15 per cent incidence of development of malignancy in sacrococcygeal teratomas. Usually only one tissue element becomes malignant. Complete and early excision of the tumor by the posterior route is emphasized.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

LONGSTRETH, H. PAUL, BLANCO, PIO, and SANES, SAMUEL. Myxochondrosarcoma of the talus. *J. Bone & Joint Surg.*, July, 1948, 30-A, 774-778.

Primary malignant tumors of the talus are

rare. In this paper, the authors describe 10 cases collected from the available literature of the past fifty years and they add an additional case of myxochondrosarcoma of the talus in a man, sixty-two years old. The findings of the collected cases and of their patient are given in detail. The latter was the oldest patient in whom this tumor had been described. The tumor was of the central, not the peripheral type. It had extended to the overlying soft parts and formed a fluctuant, pseudocystic, hemorrhagic mass which, with the bone destruction, gave suggestive roentgenographic evidence of the condition. No other patient, reported in the literature, had received roentgen therapy before operation. Whether this treatment had any effect upon inhibiting the growth and spread of the tumor, or upon producing regressive changes in it remains a matter for speculation. The irradiation did not destroy it. In chondrosarcoma of one of the bones of the foot, amputation above the ankle joint is advised, rather than local excision.

The authors' case illustrated that, as in other bones, chondrosarcoma of the talus runs a slow course with metastases, chiefly by way of the veins, to the lungs and the heart. The patient was followed for three years from the onset of symptoms to death from suicide. In no previously reported case of chondrosarcoma of the talus in the literature was an autopsy performed or was the patient proved to have visceral metastases.—*R. S. Bromer, M. D.*

REICH, CARL, and BRODSKY, ALEXANDER E. Coexisting multiple myeloma and Paget's disease of bone treated with stilbamidine. *J. Bone & Joint Surg.*, July, 1948, 30-A, 642-646.

The object of this report as stated by the authors is, first, to describe a case of coexistent multiple myeloma and Paget's disease of bone, and second, to set forth their experiences with stilbamidine in treating this case of multiple myeloma. The diagnosis of multiple myeloma was definitely established in the patient by sternal-marrow studies, but no biopsy material could be obtained from the affected left hip. However the roentgenographic appearance of the femur unquestionably fulfilled the classical criteria of Paget's disease of bone. They are unable to explain the appearance of these two disease entities in their patient, or to postulate any tenable cause-and-effect relationship of the two.

They feel it is important, especially for diagnostic significance and for proper management of the patient, to point out that the two may coexist. Upon looking at the patient's roentgenograms, one might be tempted to explain the appearance on the basis of Paget's disease alone, for the areas of circumscribed osteoporosis, which in this case were caused by multiple myeloma, could have been interpreted as the "osteoporosis circumscripta" of early Paget lesions which they resemble. They believe, also, that their case would indicate the advisability of excluding multiple myeloma, by means of bone marrow studies in those cases of Paget's disease where there are areas of circumscribed osteoporosis, even in the absence of Bence-Jones proteinuria and hyperglobulin-anemia.

Because the roentgenographic appearance of Paget's disease occasionally is simulated by metastases of carcinoma of the prostate, a careful work-up was done to exclude this possibility. No prostatic or other condition to produce this picture was found. The additional possibility of multiple myeloma producing Paget-like changes in the roentgenogram can be ruled out by the absence of any mention of such an occurrence in the numerous reports on multiple myeloma.

Treatment with stilbamidine (a total of 2.85 grams) caused early disappearance of all pain and increased the spinal mobility of the patient. Basophilic granules, which had not been present prior to therapy, appeared in the cytoplasm of the myeloma cells. The patient experienced no serious or permanent ill effects attributable to therapy. The transitory ill effects accompanying the administration of stilbamidine can be avoided by certain simple precautions which they enumerate in the paper.—*R. S. Bromer, M.D.*

BLOOD AND LYMPH SYSTEM

HOSTER, H. A., DRATMAN, M. B., CRAVER, L. F., and ROLNICK, H. A. Hodgkin's disease. *Cancer Research*, Jan.-Feb., 1948, 8, 1-78.

The purpose of the article is to "stimulate interest and research in Hodgkin's disease and allied fields of investigation." The paper is an extensive review of the literature on all phases of Hodgkin's disease and presents the opinions of many investigators as well as the results of recent scientific investigation. A study as comprehensive as this cannot be summarized

in the usual space allotted to an abstract.—*John DeCarlo, Jr., M.D.*

JACKSON, HENRY, JR. The practical aspects of the diagnosis, treatment and prognosis of Hodgkin's disease and allied disorders. *Radiology*, April, 1948, 50, 481-485.

The author, feeling that the term "malignant lymphoma" is too inclusive and actually meaningless, offers a classification which differs only in minor respects from other classification but justifies it on the basis of differences in age, symptoms, therapeutic response and prognosis of various types.

He divides Hodgkin's disease itself into three types: (1) comparatively benign para granuloma, (2) more frequent and fatal granuloma, (3) rare but extremely malignant sarcomatous type.

Giant follicular lymphoma may change to more malignant forms such as Hodgkin's disease and lymphosarcoma. Lymphosarcoma, reticulum cell sarcoma, plasmocytoma and endothelioma are placed in a general group.

The author reviews the relative incidence, ages and symptomatology of the various groups and recommends the types of therapy for each group. Prognosis is summarized for the individual types.—*Robert D. Moreton, M.D.*

HARE, HUGH F., MULRY, WILLIAM C., and SORNBERGER, C. FRANKLIN. Lymphoid tumors. *Radiology*, April, 1948, 50, 506-514.

The authors deplore the defeatist attitude of the general practitioner and specialists toward lymphoid tumors and point out the necessity for a uniform classification.

The classification used in this article is based on the origin of these tumors from a reticulum cell source. From the lymphoid phase of the reticulum cell, lymphosarcoma, lymphocytoma, and lymphatic leukemia are derived; from the reticulum side, Hodgkin's disease develops and from another unclassified section of the reticulum cell, the macrofollicular lymphoma takes its origin.

The authors discuss in detail the etiology, incidence and course of these tumors with the conditions in which a differential diagnosis must be made.

Roentgen therapy as recommended by the authors in both localized and generalized forms of the disease is presented.—*Robert D. Moreton, M.D.*

MOFFITT, HERBERT C., and LAWRENCE, JOHN H. Chronic leukemia of long duration; with a report of 31 cases with a duration of over five years. *Ann. Int. Med.*, April, 1949, 30, 778-790.

The actual disease process may antedate the onset of symptoms by a considerable period. It is well known that chronic leukemia may be detected from routine examination of the blood prior to the onset of any symptoms. Wintrobe and Hasenbush estimate that two to five years—or longer—elapse between the actual time of onset of chronic myelogenous leukemia and the time when symptoms cause the patient to seek medical aid. In chronic lymphatic leukemia they found that one and a half to two and a half years passed between the finding of signs of the disease (leukocytosis, glandular enlargement, or splenomegaly) and the development of symptoms of the disease. They believed lymphatic leukemia was discovered earlier in its course because of the associated lymph node enlargement.

In the course of leukemia, remissions, both symptomatic and hematologic, may occur spontaneously as well as from the effects of treatment. Such spontaneous remissions may contribute to the long duration of many of the unusual cases under discussion but no cause—other than natural variation in the disease—has ever been definitely established for their occurrence.

Various types of infection have been reported as a cause of remission in leukemia. Infection might, therefore, be a factor in cases of long duration. Forkner reviewed the pertinent literature and concluded that, although many miscellaneous infections were associated at times with evidences of regression, in all instances in which recovery from infection occurred leukemic manifestations recurred, usually in a few weeks.

It is generously agreed that there is not yet clean cut evidence that treatment has significantly prolonged the duration of any type of chronic leukemia. However, practically all agree that radiation therapy lengthens the period of comfortable and useful life. The possibility of cure of leukemia is still undetermined. Until more is known about the etiology of leukemia, it cannot be stated definitely whether recovery is possible.

Pascucci summarized the factors which were associated with short duration of the disease in his series of 128 patients from the Presby-

terian Hospital in New York. He listed the following findings as indicating a poor prognosis, but stated there were few substantiating statistics: very high or very low white blood cell count, serious anemia, high number of blast cells, excessively high or excessively low platelet count, marked splenomegaly, diffuse lymph node involvement, presence of complications (hydrothorax, pneumonia, tuberculosis, osteomyelitis, cardiovascular disease, etc.) and short duration of symptoms prior to diagnosis.—*Eugene J. McDonald, M.D.*

FARBER, S., DIAMOND, L. K., MERCER, R. D., SYLVESTER, R. F., and WOLFF, J. A. Temporary remissions in acute leukemia in children produced by folic acid antagonist, 4-aminopteroyl-glutamic acid (aminopterin). *New England J. Med.*, June 3, 1948, 238, 787-793.

The observation by Farber that leukemic children treated with certain folic acid conjugates showed exaggeration or acceleration of the leukemic process suggested that folic acid antagonists might be of value in patients with acute leukemia. After studies with pteroylaspatic acid and methylpterioic acid on 21 patients, a more potent agent, 4-aminopteroyl-glutamic acid (aminopterin) became available.

In 16 infants and children with acute leukemia treated with aminopterin intramuscularly, 10 showed clinical, hematologic, and pathological evidences of important improvement, although many were moribund at onset of therapy. Six did not respond well; 4 of these are dead, and 2 unimproved. Five of the 10 cases showing significant improvement are presented in detail.

Aminopterin has a marked effect on leukemic bone marrow, on immature cells in the peripheral blood, and very probably on leukemic deposits in the viscera as well. In the treated patients, the white count tended to return to normal, regardless of whether the initial count was abnormally high or indicated a marked leukopenia. The percentage of immature cells fell, and blast forms decreased or disappeared from the peripheral blood. Hemoglobin, red blood cell count, and platelet values approached normal, as did the relative percentage of mature leukocytes in the peripheral blood. Bone marrow studies showed decrease or disappearance of leukemic cells. Enlarged livers of spleens return toward normal size, and adenopathy may disappear.

The authors emphasize that remissions so far have been of short duration, that toxic effects such as stomatitis are already known, that at least 2 of their improved cases had previously shown brief remissions following intercurrent bacteriemias, and that there is as yet no justification for the assumption that a cure for acute leukemia in children has been found.—*Henry P. Brean, M.D.*

UHLMANN, ERICH M. The significance of giant follicular lymphadenopathy (Brill-Symmers disease). *Radiology*, Feb., 1948, 50, 147-156.

Giant follicular lymphadenopathy (Brill-Symmers disease), a condition of rising importance, but little known by the medical profession in general, constitutes a disease entity which may eventually be followed by lymphatic leukemia, polymorphous cell sarcoma, or Hodgkin's disease.

Originally described by Becker in 1901, it was named by Symmers (1927) and is not an uncommon condition.

Characterized by localized or generalized, soft, painless lymphadenopathy, it is often misdiagnosed as Hodgkin's disease. The size, position, or growth rate of the nodes is not regular or characteristic. Splenomegaly may be present, and the peripheral blood is normal. There is no sex preference and the greatest incidence is in the third and fourth decades.

The microscopic picture is characteristic, with change but not destruction of the follicular structure. Often the follicles are filled with large hypochromatic or even achromatic nuclei and the peripheral zone of leukocytes may be absent. Occasionally, the follicles may be made up entirely of small lymphocytes. The change marking the transition to polymorphous cell sarcoma is rupture of the follicles, and invasion of the cells within the surrounding tissues. The nodes may remain static for long periods, but

later show transition to one of the more malignant forms.

Briefs of 22 cases with follow-ups varying from one case still under treatment up to a case nine years after treatment, shows 6 deaths; 3 from leukemia, 1 from Hodgkin's disease, 1 from leukosarcomatosis. The author feels that intensive radiation therapy was responsible for the wellbeing of the 9 patients still alive, three to nine years after therapy. Whereas small doses produce regression of the nodes, recurrence is common, and with large doses of radiation, prognosis is better. This condition should be treated from the start as a malignant lesion, not as a benign or a potentially malignant one. This, the author believes, will usually prevent the development of a malignant lymphoma.—*George D. Adams, M.D.*

CALME, A. Application d'une nouvelle substance iodée à l'artériographie et à la phlébographie. (Employment of a new iodized substance in arteriography and phlebography.) *J. de radiol. et d'électrol.*, No. 3-4, 1948, 29, 101-107.

From the Surgical Clinic of the University of Geneva the author reports the use of a new radiopaque substance in arteriography and phlebography. The report covers 60 arteriograms and phlebograms with the new substance having the trade name Savac. It is chemically a salt of a diethanolamine of a diiodopyridone in 30 per cent solution. One of the illustrations shows a beautiful cerebral arteriogram using 20 cc. of the solution. The material is well tolerated by the patients, the roentgenograms clear and very satisfactory. The material was developed for use in visualization of the circulatory system because the substance of choice (vasoselectan) could no longer be obtained.—*William M. Loehr, M.D.*



THE AMERICAN JOURNAL
OF ROENTGENOLOGY
AND RADIUM THERAPY

VOL. 62 SEPTEMBER, 1949 No. 3

ROENTGEN THERAPY AS THE SOLE METHOD OF
TREATMENT OF CANCER OF THE BREAST*

By DR. F. BACLESSE
Fondation Curie
PARIS, FRANCE

THE use of roentgen therapy as the sole method of treatment in cancer of the breast is based on the results obtained from the use of preoperative roentgen therapy in high dosage, followed by radical mastectomy.

The following is a table correlating the histopathological effect of irradiation on the tumor with the five year results in 58

cases treated with roentgen therapy plus radical surgery from 1936 to 1942 at the Curie Foundation (Table I).

Table I shows three important facts. (1) The cases in which the tumor was histopathologically completely sterilized or in which it was *almost* completely sterilized have given no local recurrence. (2) Recurrences appeared only in the advanced

TABLE I
MAMMARY CANCER; ROENTGEN THERAPY PLUS SURGERY (HALSTED); FIVE YEAR RESULTS

Histopathology	No. of Treated Cases	Clinical Healing after 5 Years	Local Recurrence	Died of Metastasis	Died of Inter-current Disease	Untraced	Post-operative Death
Complete cell death	12	8		3	1		
Questionable cell death	8	4		3		1	
Marked histopathological change	13	6		6			1
Moderate histopathological change	25	9	7	8	2		5
Total	58	27	7	20	3	1	6

Five year results of 58 cases (Stages II and III), treated by roentgen therapy with high doses, followed by radical mastectomy (1936-1942).

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

cases where the histopathological changes as a result of therapy were not so marked, and of special interest is the fact that all

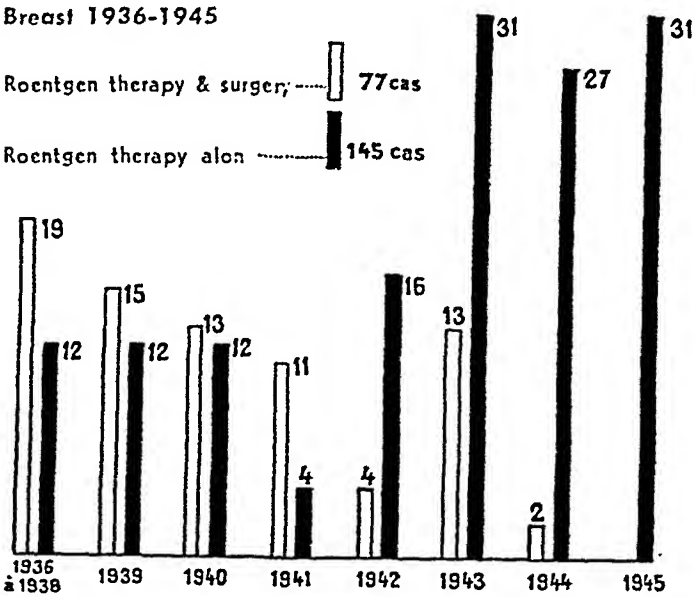


FIG. 1. Number of cases of cancer of the breast treated by each method in the years 1936-1945.

the local recurrences were associated with distant metastases. (3) Moreover, these advanced cases, irradiated with high doses and then operated upon, have produced 5 postoperative deaths. Thus, it is apparent

that an advanced cancer, highly irradiated, must not be operated upon except in very special instances, because there is danger of local recurrence associated with distant metastases, and there is a high percentage of postoperative deaths.

In the case of the axillary lymph nodes the results are not so evident, as lower doses must be given in view of the contemplated extensive dissection, and these lower doses will not produce sterilization except in rare cases of very sensitive tumors (Table II).

Figure 1 shows the evolution of the radiotherapeutic method in one roentgen-ray department of the Curie Foundation, from 1936 to 1945. It is noted in this figure that a progressively greater percentage of cases is being treated by roentgen therapy alone.

In the first part of this paper we will discuss the immediate results after one, three, and five years, in mammary tumors, the axillary lymph nodes, and the supra-clavicular lymph nodes, all considered separately. This is the analysis of the local and regional problem. These results will show

TABLE II
MAMMARY CANCER; ROENTGEN THERAPY PLUS SURGERY (HALSTED); FIVE YEAR RESULTS

Histopathology	Stage II							Stage III						
	Number of cases treated	Clinical healing after 5 years	Died of local recurrence	Died of metastases	Died of inter-current disease	Untraced	Postoperative deaths	Number of cases treated	Clinical healing after 5 years	Died of local recurrence	Died of metastases	Died of inter-current disease	Untraced	Postoperative deaths
Complete cell death	8	6	0	2	0	0	0	4	2	0	1	1	0	0
Questionable cell death	4	2	0	1	0	1	0	4	2	0	2	0	0	0
Marked histopathological change	4	3	0	1	0	0	0	9	3	0	5	0	0	1
Moderate histopathological change	11	6	1	2	2	0	0	14	3	6	6	0	0	5
Total	27	17	1	6	2	1	0	31	10	6	14	1	0	6

The same cases as shown in Table 1, grouped according to the stages of disease (Stage II and III).

TABLE III

Clinical Aspect of the Mammary Tumor	No. of Cases Treated	Clinical Disappearance of Tumors at End of Treatment and End of First Year	Proved by Biopsy Disappearance of Tumors	Clinical Healing after 3 Years
Tumor from 4 to 6 cm., movable, thickened or invaded skin, nipple retracted or not	33	27	17	22
Tumor over 6 cm., movable or not, thickened or invaded skin, or edema, "peau d'orange," skin nodules	42	25	10	8
Ulcerated tumor	28	15	10	7
Extensive scirrhous, ulcerated or not, fixed to depth	9	7	3	2
Acute inflammatory tumor	5	1	0	0
Distant metastases (skin, lungs, bones). Tumor immediately bilateral	13	4	2	2
Total	130	79	42	41

Showing local results (apparent clinical disappearance of the mammary tumor) at the end of the treatment, one and three years after the end of this treatment, for 130 mammary carcinomas (Stages II to IV) irradiated during the period from 1936 to 1945.

us if we are justified in continuing this type of treatment.

In the second part of the paper, we will report the statistical studies, stage by stage.

CLASSIFICATION OF MAMMARY TUMORS

The following factors are taken into consideration:

1. Volume (less than 6 cm., and greater than 6 cm., in diameter).
2. Skin invasion.
3. Skin edema.
4. Peau d'orange.
5. Skin nodules.
6. Ulceration.
7. Inflammatory carcinoma.
8. Scirrhous carcinoma (this is placed in a separate group).

The stages of carcinoma of the breast which are considered in this paper are Stages II, III and IV. For the purposes of evaluation of the statistical tables shown later in the paper, we will now state the lesions included in the various stages:

- Stage II—tumors up to 6 cm. in diameter.
 —thickened or invaded skin.
 —nipple retracted or not.
- Stage III—Tumors over 6 cm. in diameter.
 —edema, peau d'orange, skin nodules.

—ulcerated tumors.

—scirrhous

—extensive

—ulcerated or not

—fixed to deep tissues.

Stage IV—distant metastases

—inflammatory carcinoma

Note: We are also considering in a special group and eliminating from the statistics, cases up to 3 cm. in diameter (Stage I, 10 cases), where a surgical biopsy removed the small tumor (by microscopic proof).

BEHAVIOR OF THE MAMMARY TUMOR AND THE LYMPH NODES

I. The mammary tumor.

Table III summarizes the results of 130 cases from 1936 to 1945.

Clinical disappearance was obtained after one year in 79 cases, of which 42 had been biopsied (surgical biopsy).

At the end of the third year the number of locally healed patients, living and symptom free, is 41.

Table IV shows the condition of 52 patients at the end of the fifth year (1936-1942), in Stages II, III and IV. Clinical disappearance of the tumor was obtained in 9 cases. Only 2 local recurrences have been noted during the third and fourth years, one in a Stage II case and the other

TABLE IV

Clinical Aspect of the Mammary Tumor	No. of Cases Treated	Clinical Disappearance of Tumors at End of Treatment and End of First Year	Proved by Biopsy Disappearance of Tumors	Clinical Healing after 5 Years
Tumor from 4 to 6 cm., movable, thickened or invaded skin, nipple retracted or not	10	6	1	4
Tumor over 6 cm., movable or not, thickened or invaded skin, or edema, "peau d'orange," skin nodules	18	8	1	2
Ulcerated tumor	13	5	4	2
Extensive scirrhus, ulcerated or not, fixed to deep tissues	4	3	1	0
Inflammatory carcinoma	3	1	0	0
Distant metastases (skin, lungs, bones). Tumor initially bilateral	4	2	0	1
Total	52	25	7	9

Local conditions of irradiated breasts after *five years* in 52 patients treated from 1936 to 1942 (Stages II to IV). The number of biopsies concerns only the tumors which clinically disappeared. The diminution of the number of survivals is due, chiefly, to distant metastases.

in a Stage III case. The deaths are due chiefly to the appearance of distant metastases outside the irradiated region. However, it is not possible to draw definite conclusions, because the number of these patients is too small, and among the patients dead from metastases and untraced, there may be tumors not histopathologically sterilized, but which had no opportunity of recurring clinically as the patients died too soon.

Table v shows the fate of the 130 cases during the second and third years.

2. The axillary lymph nodes.

In these, complete disappearance is more difficult to obtain.

Grouping these lymph nodes according to size, Table VI shows that in 52 cases with lymph nodes from 3 to 5 cm. in size, 26 disappeared at the end of treatment and 10 remained absent for three to five years following.

It must be noted that these lymph nodes, as well as the supraclavicular ones, have not been histopathologically proved to contain malignant cells.

3. The supraclavicular lymph nodes.

Table VII shows the results of treatment

TABLE V

	Stage II		Stage III		Stage IV	
No. of cases treated	33		79		18	
Clinical disappearance verified after 1 year	27	-5	47	-29	5	-3
Clinical disappearance verified after 3 years	22		18		2	
Died of local recurrence	1	+5	1	+29	0	
Died of distant metastases	4		17		1	+3
Untraced	0		7		1	
Died of intercurrent disease	0		4		1	

here. The survival rate diminishes considerably in the year following irradiation, not because of supraclavicular recurrence, but due to distant metastases, especially in the cases where the nodes were initially large.

STATISTICAL STUDIES

After having considered the individual behavior of the mammary, axillary and supraclavicular tumors, we present the statistics as five year results, the patients being grouped in Stages II, III and IV (Table VIII).

Of 52 patients treated from 1936 to 1942, 8 are living after five years without any clinical evidence of cancer locally or at a distance. Four of these tumors had initial biopsies. Twenty-four distant metastases may be noted, a very high rate.

Table IX is not statistical, but shows only the local condition of the breast at the end of the third year. Of 130 patients, 41 are living and symptom free; 47 distant metastases are noted.

There are 10 Stage I tumors; the tumor was irradiated locally and completely *after a biopsy*. Nine of these patients are locally healed and symptom free after a period of three to five years. No case of local recurrence was noted, but one death from rapid metastasis occurred, the patient dying from massive liver metastasis only two months following treatment.

TABLE VI
AXILLARY LYMPH NODES

Size of Lymph Nodes	No. of Cases Treated	Clinical Disappearance at the End of Treatment	Clinical Disappearance Verified after 3 to 5 Years
0 cm.	40		
0.5 cm.	19		
1-2 cm.	34		
3-5 cm.	52	26	10

Behavior of the axillary lymph nodes in 145 patients irradiated from 1936 to 1945. Only the lymph nodes (without biopsy) appearing clinically malignant and with a volume of more than 2 cm. are counted. The apparent clinical disappearance of lymph nodes under this volume (from 0.5 to 2 cm.) was obtained in a greater percentage, but these lymph nodes are eliminated from this study because they are clinically doubtful. Thus we attempt to compensate for the absence of biopsy by using more strict clinical criteria.

TECHNICAL CONSIDERATIONS

The technique is similar to that used for other cancers, namely, 180 kv.; filter 1 mm. of copper; target skin distance 60 cm.; intensity 20 r per minute. More important is the planning of the fields, dose per treatment, total dose, and fractionation.

Fields: The average number of fields is six to seven, and the size varies from 10 by 10 cm. to 12 by 10 cm., the size being reduced near the end of the treatment when the dosage becomes high. Overlapping must be avoided, and this is made possible by marking three landmarks on

TABLE VII
SUPRACLAVICULAR LYMPH NODES

Size of Lymph Nodes	No. of Cases Treated	Clinical Disappearance at the End of Treatment	Clinical Disappearance Verified after 1 Year	Clinical Disappearance Verified after 5 Years
0.5-1 cm.	21	11	4	2
1.5-3 cm.	20	9*	2	1
3-7 cm.	16	5*	1	0

Behavior of the supraclavicular lymph nodes. This table includes the patients treated by roentgen therapy alone, and the postoperative recurrences grouped together. We added to this table postoperative recurrences with clinically evident supraclavicular lymph nodes to increase the number of studied cases. Out of 14 cases (9*+5*) with lymph nodes larger than 1 cm., 7 were non-operated patients and 7 were postoperative recurrences. The diminution of the number of survivals noted after the first year is due, not to a supraclavicular recurrence, but to distant metastases.

TABLE VIII

	Without Lymph Nodes				Axillary Lymph Nodes				Supraclavicular Lymph Nodes				Total			
	Cases treated	Apparent healing after 5 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 5 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 5 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 5 years	Proved by biopsy disappearance of tumors	Died of distant metastases
Tumor from 4 to 6 cm., movable thickened or invaded skin nipple retracted or not	5	2	0	2	5	2	1	1					10	4	1	3
Tumor over 6 cm., movable or not; skin thickened or invaded	3	1	1	1	5	0	0	4	1	0	0	1	9	1	1	6
Tumor over 6 cm., edema, "peau d'orange," skin nodules					9	0	0	5					9	0	0	5
Ulcerated tumor	5	1	1	0	7	1	1	3	1	0	0	1	13	2	2	4
Extensive scirrhous, ulcerated or not, fixed to deep tissues					3	0	0	1	1	0	0	0	4	0	0	1
Inflammatory carcinoma					3	0	0	2					3	0	0	2
Distant metastases (skin, lungs, bones), tumor initially bilateral					4	1	0	3					4	1	0	3
Total	13	4	2	3	36	4	2	19	3				52	8	4	24

Statistical studies of 52 patients (Stages II, III, IV), treated by roentgen therapy alone (*five year results*). The patients are grouped according to the clinical aspect of the breast tumor and the axillary and supraclavicular lymph nodes. Note the frequency of metastasis which gets higher with the increasing invasion of axillary and supraclavicular lymphatics. The biopsies noted concern exclusively the tumors which disappeared.

To simplify the table, the patients untraced or dead from intercurrent disease are not counted here, but only distant metastases.

TABLE IX

	Without Lymph Nodes				Axillary Lymph Nodes				Supraclavicular Lymph Nodes				Total			
	Cases treated	Apparent healing after 3 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 3 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 3 years	Proved by biopsy disappearance of tumors	Died of distant metastases	Cases treated	Apparent healing after 3 years	Proved by biopsy disappearance of tumors	Died of distant metastases
Tumor 4 to 6 cm., movable, thickened or invaded skin (nipple retracted or not)	12	8	2	2	21	14	12	4					33	22	14	6
Tumor over 6 cm. (movable or not), skin thickened or invaded	5	3	2	1	22	3	1	11	2	0	0	1	29	6	3	13
Tumor over 6 cm., edema, "peau d'orange," skin nodules					13	2	2	6					13	2	2	6
Ulcerated tumor	5	1	1	1	21	6	4	6	2	0	0	1	28	7	5	8
Extensive scirrhous ulcerated or not; fixed to deep tissues	3	1	1	1	5	1	1	1	1	0	0	0	9	2	2	2
Inflammatory carcinoma					4	0	0	2	1	0	0	1	5	0	0	3
Distant metastases (skin, lungs, bones), tumor initially bilateral					9	2	2	6	4	0	0	3	13	2	2	9
Total	25	13	6	5	95	28	22	36	10	0	0	5	130	41	28	47

Local conditions of 130 patients (Stages II, III, IV) treated by roentgen therapy alone (*three year results*). The patients are grouped according to the clinical aspect of the breast tumor and the axillary and supraclavicular lymph nodes. Note the frequency of metastasis which increases with the increasing invasion of axillary and supraclavicular lymphatics. The biopsies noted concern exclusively the tumors which disappeared.

To simplify the table, the patients untraced or dead from intercurrent disease are not counted here, but only distant metastases.

TABLE X

Tumor Dose (Mid-point of Breast) in Roentgens	Tumor 4 to 6 cm., Movable Thickened or Invaded Skin, Nipple Retracted or Not			Tumor over 6 cm., Movable or Not, Thickened or Invaded Skin, or Edema, "Peau d'orange," Skin Nodules			Ulcerated Tumor			Extensive Scirrhous, Ulcerated or not, Fixed to Deep Tissues			Inflammatory Carcinoma		
	Cases treated	Disappearance of tumors at end of treatment	Proved by biopsy	Cases treated	Disappearance of tumors at end of treatment	Proved by biopsy	Cases treated	Disappearance of tumors at end of treatment	Proved by biopsy	Cases treated	Disappearance of tumors at end of treatment	Proved by biopsy	Cases treated	Disappearance of tumors at end of treatment	Proved by biopsy
4,100	3	3	0				1	0	1						
4,500 to 5,000	1	0	0	8	2	1	4	0	3	1	0	1	1	0	0
6,000 to 6,800	7	6	5	14	9	3	6	3	4	3	2	1	1	1	0
7,000 to 8,000	14	12	7	11	6	4	2	2	1	2	2	1	3	0	0
9,000	4	3	3	5	4	3	8	5	5	1	1	1			
over 9,000	4	3	3	4	4	2	7	5	6	2	2	2			
Total	33	27	18	42	25	13	28	15	20	9	7	6	5	1	0

Showing the approximate tumor dose, evaluated in the center of the breast applied through two mammary fields right and left apposing. The apparent clinical disappearance of the tumor in these cases has been noted one year at least after the treatment. We noticed that this clinical disappearance is obtained, in a significant proportion, only after a dose of about 5,000 r.

Number of irradiated patients: 117. Not considered in this table: 18 patients of Stage I and Stage IV.

TABLE XI

Clinical Aspect of the Mammary Tumor	4 to 6 Weeks			6 to 8 Weeks			8 to 10 Weeks			10 to 11 Weeks			11 to 12 Weeks			12 to 14 Weeks			14 Weeks and More		
	Clinically Well			Clinically Well			Clinically Well			Clinically Well			Clinically Well			Clinically Well			Clinically Well		
	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy	Cases treated	After 3 years	Proved by biopsy
Tumor from 4 to 6 cm., movable, thickened or invaded skin (nipple re- tracted or not)	5	3	0	0	0	0	1	1	0	6	4	4	9	5	4	4	1	1	8	8	6
Tumor over 6 cm. (mov- able or not), thickened or invaded skin, or edema, "peau d'orange," skin nodules				5	0	0	5	0	0	1	0	0	7	3	2	15	4	2	9	1	1
Ulcerated tumor	1	0	0	1	0	0				4	0	0	5	2	1	6	1	1	11	4	3
Extensive scirrhous (ulcer- ated or not) fixed to deep tissues	1	0	0							3	0	0	1	0	0	1	1	1	3	1	1
Inflammatory carcinoma Distant metastases (skin, lungs, bones), tumor ini- tially bilateral				1	0	0	1	0	0				1	0	0	3	0	0	2	0	0
Total	7	3	0	7	0	0	7	1	0	14	4	4	23	10	7	35	9	5	37	14	11

Showing the results of various methods of fractionation in 130 breast carcinomas (Stages II to IV); three year results (1936 to 1945). It is imperative to use the fractionation method to avoid accidents. The treatment period increases with the given dose. In our present policy, the lower limit of this fractionating is *three months*.

the skin at the confluence of fields (see Fig. 2, 3 and 4). The two mammary fields

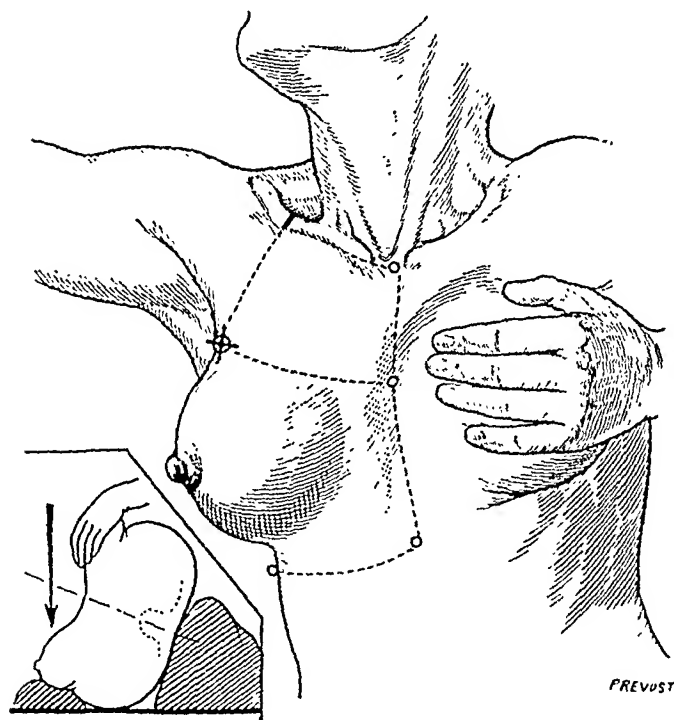


FIG. 2

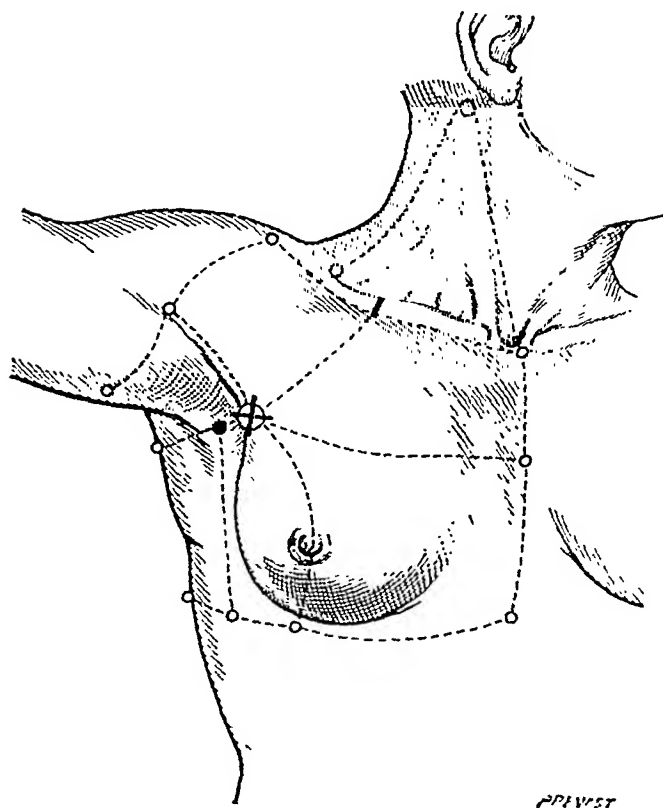


FIG. 3

must be applied tangentially to the chest wall, and directly opposing; if the breast is very large, a third mammary field is

applied as a direct anterior field. Irradiation must be applied following a rhythmical alteration with an interval of two to three days between successive treatments to any one field.

Total dose: The tumor dose has been evaluated in Table x for 117 patients (three year results).

It is seen from Table x that local clinical disappearance becomes more frequent after a tumor dose of 6,000 to 6,800 r.

The tumor dose in the axillary lymph nodes varied from 6,000 to 7,000 r in the

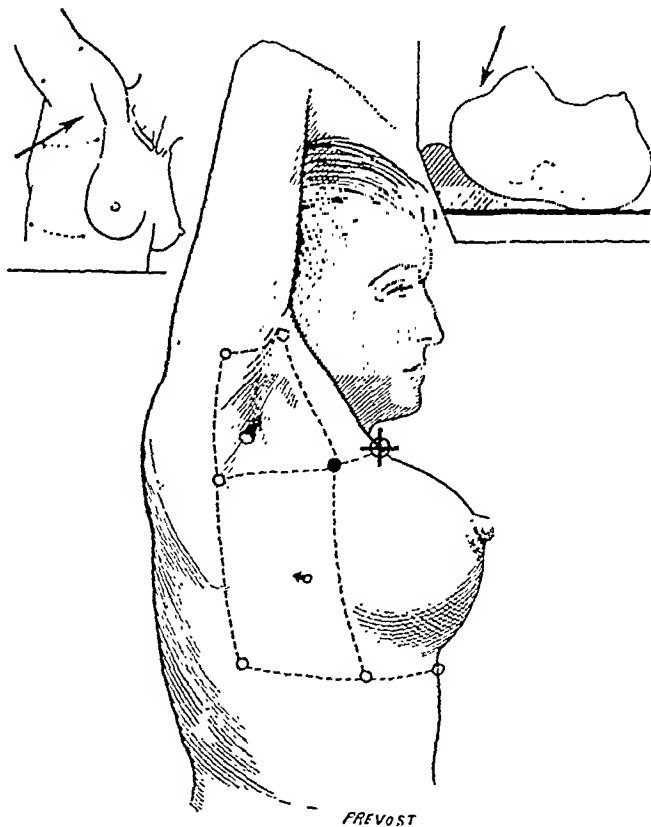


FIG. 4

lymph nodes which disappeared clinically.

The skin dose for the supraclavicular nodes is at least 4,500 to 5,200 r (4,100 r in one case only).

It must be remembered that this is only the clinical disappearance of the tumor that we are considering, and we emphasize that it is not possible to say if the mammary tumor and the lymph nodes have histopathologically disappeared after this short time of three years.

These very high doses are only advisable with protracted fractionation.

Fractionation: Table XI shows the fractionation for 130 cases (Stage II, III and IV) (five year result at least).

The fractionation is increased with increasing total doses, which themselves vary with the extent and size of the mammary tumor and of the lymph nodes.

Treatment is usually fractionated over three months, and over four months in the intensive and radioresistant lesions.

For the supraclavicular region, one field is used; the average fractionation period is three months, for the doses indicated previously. This is the only way to avoid late skin changes. The daily dose per field varies from 200 to 250 r, in exceptional cases (and temporarily only) 300 r per field (skin dose). Two fields are treated daily—rarely three (and only temporarily), when the patient is obese and in good general health.

COMPLICATIONS

These vary according to the dose administered and the fields utilized. The tissues affected are skin, subcutaneous tissues, muscles and nerves, bones (fractures), lungs and heart. They are due to obvious mistakes, because of too high doses, too

large fields (and overlapping), and faulty direction of the beam.

SUMMARY

Roentgen therapy of the breast as here described is a treatment confined exclusively to the breast and regional lymphatic areas. It is concerned only with the clinical disappearance of the mammary tumor and the lymph nodes after periods of three to five years following treatment. It does not deal with the treatment of distant metastases which remains a separate problem and is not discussed here.

The patients reported here with a mammary tumor or axillary or supraclavicular nodes clinically disappeared, are patients living at this time, three to five years at least after the treatment, without evidence of distant metastases, and symptom free.

The patients dead from distant metastases are counted as failures even when the mammary tumor and lymph nodes had disappeared completely at the time of death.*

Fondation Curie
Paris, France

* For discussion see page 349.



TREATMENT AND RESULTS IN CANCER OF THE BREAST*

By ELIS BERVEN, M.D.

Professor of Radiotherapy, University of Stockholm; Director of Radiumhemmet

STOCKHOLM, SWEDEN

AT Radiumhemmet all cases of cancer of the breast are clinically examined not only by an experienced surgeon but also by at least two radiotherapists. These three specialists class a given case, on the basis of their clinical findings, according to the three stages suggested by Steinthal. Nevertheless, our experience at Radiumhemmet has shown that in 15 per cent of the cases which had clinically been classed Stage I (Steinthal), the microscopic examination disclosed that they were Stage II cases. In addition, the microscopic examination showed in almost one-third of these cases that the tumor had grown through the capsule of the lymph node. The latter condition is, in the light of prognosis, a very unfavorable sign, which the clinical examination fails to reveal.

Also in about 30 per cent of the cases which are clinically classed Stage II the microscopic examination of the axillary lymph nodes showed that they were Stage I cases. The percentage of this incorrect classification published in the literature is, as a rule, much higher.

If the classification of cases of cancer of the breast is based only on clinical findings the results of radiation treatment of cancer of the breast published by different clinics are statistically not comparable. A classification according to Steinthal therefore cannot be used as a basis for comparative statistical studies. The staging of cancers of the breast must be based on the findings of a careful microscopic examination of all axillary lymph nodes.

Apart from metastasis to the axilla, other symptoms such as fixation to the skin or ulceration of the tumor have a comparatively insignificant bearing on prognosis.

Since 1921 we have largely been using the same methods at Radiumhemmet; namely, either only postoperative or preoperative and postoperative roentgen treatment.

The patients treated at Radiumhemmet are referred either from general County Hospitals in the North of Sweden and Mid-Sweden, or from the Karolinska Hospital in Stockholm, the surgical mother-clinic of Radiumhemmet. From the clinical point of view, these cases vary widely. From the Karolinska Hospital all operable cases are referred no matter in which stage they are clinically.

From the County Hospitals, however, only about 60 per cent of the operable cases are referred for radiation treatment. The reason for this is that the surgeons-in-chief in these hospitals do not refer early cases which in their opinion are in Stage I (Steinthal) for preoperative treatment, because they feel that surgical treatment alone yields fully satisfactory results in such cases. If, however, in these cases there is microscopic evidence of metastases to the axillary nodes, the patients are referred for postoperative treatment. Hence in the light of prognosis the cases referred to Radiumhemmet from these hospitals are rather bad, far-advanced cases.

On the other hand, for primary preoperative treatment, only such patients are usually referred in whom metastases to the axillary nodes were clinically demonstrable or who surgically were borderline cases. Hence, also the cases sent to Radiumhemmet from the County Hospitals for preoperative treatment are, as regards prognosis, fairly unfavorable cases.

In preoperative treatment roentgen rays are given to a large anterior field (20 by 30

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

cm.), including the breast, axilla and the supraclavicular fossa. The breast is lifted up and fixed with sandbags in the axilla. In addition, treatment is given through a posterior field (10 by 15 cm.), covering the breast (still fixed in the axilla) and the axilla. We give nowadays to each field 350 r each time, five times using 180 kv., 0.5 mm. Cu filter, 50 cm. target-skin distance; the total tumor dose given over ten days is approximately 2,000 r, that given to the axilla, approximately 1,500 r.

If the breast is small and if the tumor is localized to the medial part of the breast, four portals are used, namely a medial and a lateral to the breast, and an anterior and a posterior, including the axilla.

Although this dosage produces a mild erythema of the skin it does not affect the healing process after operation. The operation is performed three weeks after the end of the treatment.

As soon as the surgical wound is healed the first postoperative treatment is given using two fields, i.e. a large anterior field including the operated area and the supraclavicular fossa and a posterior field including the axilla and the supraclavicular fossa. To the anterior field we give 300 r each time, three times using 102 kv., 1 mm. Al filter, 50 cm. target-skin distance. To the posterior field we give 3 X 350 r, 0.5 mm. Cu plus 1 mm. Al, distance 40-50 cm. After two months this treatment is repeated, and after another three months a third course of postoperative treatment is given with the same technique. This dosage is also used in cases in which the patients receive postoperative treatment only.

This technique is modified according to the type of the case and the microscopic findings. In later years, we have, in cases where the tumor is localized to the medial part of the breast, treated the mediastinum. To women at the reproductive age we give in addition a castration dose to the ovaries.

Recurrences in the skin of the operation field are rare, as seen in Table I.

Skin recurrences have developed in 88 of 802 cases, or in 10 per cent. Only 26, or 3 per cent, are real skin local recurrences

as in 52 cases the skin recurrence was a part of the generalized metastases.

In some cases where the tumor was highly radiosensitive and classed Stage II we have prophylactically also treated the spine and the pelvic bones.

In Sweden the criteria for operation are less rigid than in the United States. We consider only those cases inoperable where

TABLE I
RECURRENCES IN THE SKIN OF THE OPERATION FIELD

	No. of Cases	No. of Cases with Local Recurrences
Stage I	298	21 or 7%
Stage II	471	52 or 11%
Stage III	33	5 or 15%
Total	802	88 or 10%

Skin recurrences have developed in 88 of 802 cases, or in 10 per cent. Only 26, or 3 per cent, are real local skin recurrences as in 52 cases the skin recurrence was a part of the generalized metastases.

the tumor is fixed to the thoracic wall and where there is evidence of either massive and fixed metastases to the axillary lymph nodes or to the supraclavicular fossa or to distant organs. Fixation to the skin or ulceration of the tumor is no contraindication to operation if preoperative roentgen treatment has been given. Neither are pregnancy, lactation and the inflammatory type of carcinoma. In pregnant women pregnancy is interrupted.

In Table II the 3,623 cases observed at Radiumhemmet during the period covering the years from 1921 to 1941 are compiled.

- 1,164 cases have had preoperative and postoperative treatment.
- 640 only postoperative treatment.
- 535 cases with recurrences after operation at other clinics have had different types of radiation treatment.
- 544 cases were inoperable on admission, and have had palliative treatment only.
- Inoperable cases, which became operable after treatment are included in the pre- and post-operatively treated series.
- 740 cases were too advanced for treatment.

The comparatively small number of cases of recurrence and of cases at a very

TABLE II

FIVE YEAR RESULTS IN 3,623 CASES OF BREAST CARCINOMA OBSERVED AT RADIUMHEMMET 1921-1941
ALL DEAD CASES ARE COUNTED AS DEAD OF CANCER.

		No. of Cases	Well		Survivals	
Pre-and postoperative treatment	Period 1921-1935	607	251	41%	269	44%
Microscopic Stages I and II	Period 1936-1941	557	240	43%	286	51%
Total		1,164				
Postoperative treatment only	Period 1921-1935	428	186	43%	202	47%
Clinical Stages I and II	(only 285 micr. verified and classified)					
Microscopic Stages I and II	Period 1936-1941	212	93	44%	105	50%
Total		640				
Total of cases treated by radiation and operated on	Period 1921-1935	1,035	437	42%	471	46%
	Period 1936-1941	769	333	43%	391	51%
Total		1,804				
Radiation treated recurrences after operation	Period 1921-1935	417	40	9%	47	11%
	Period 1936-1941	118	—	—	15	13%
Total		535				
Treated	Period 1921-1935	363	—	—	32	9%
Inoperable cases	Period 1936-1941	181	—	—	5	3%
Total		544				
Cases too advanced for treatment	Period 1921-1935	635	—	—	—	—
	Period 1936-1941	105	—	—	—	—
Total		740				

advanced stage during the years 1936-1941 is due to the fact that in the majority of these hopeless cases the patients are now offered facilities for palliative roentgen treatment in the County Hospitals.

I shall confine myself to a discussion of the results in operable radiation treated cases during the two periods 1921-1935 and 1936-1941.

Only approximately 40 per cent of the operable cases are found to be in Stage I, 60 per cent in Stage II.

Unfortunately this proportion between these two stages has not improved in the past twenty-one years despite the ever-in-

creasing propaganda to seek medical advice as early as possible.

In Sweden as many as approximately 50 per cent of all breast cancers are found to be inoperable when first seen. During the first period 1921-1935, there were 1,035 cases treated (143 of them, operated upon on clinical findings without microscopic confirmation, were postoperatively treated). The five year cure rate was 42 per cent and the survival rate 46 per cent. In the second period there is a slight improvement in the results, the five year cure rate being 43 per cent and the survival rate 57 per cent (Table II).

The results in the different periods of the preoperative and postoperative and only postoperative cases in Stages I and II microscopically verified are compiled in Table III.

I will first discuss the results in the preoperatively and postoperatively treated cases. In the fifteen year period 1921-1935,

first period to 34 per cent in the second and the survival rate from 28 per cent to 43 per cent, a marked improvement.

In the postoperatively radiation treated cases it is not possible to compare the results from the different periods, since in the period 1921-1935 only in two-thirds was there microscopic evidence in support

TABLE III
CANCER OF THE BREAST
Five year results in microscopically verified Stages I and II

Stages	Pre- and Postoperative Roentgen Treatment	No. of Cases	Five Year Results			
			Well		Survivals	
I	Period 1921-1935	216	155	71%	157	72%
II	Period 1921-1935	391	96	24%	112	28%
	Total	607	251	41%	269	44%
I	Period 1936-1941	203	121	60%	135	66%
II	Period 1936-1941	354	120	34%	151	43%
	Total	557	241	43%	286	51%
Postoperative Roentgen Treatment Only						
I+II	Period 1921-1935 verified but not classified cases	285	115	40%	126	44%
I	Period 1936-1941	95	58	61%	63	66%
II	Period 1936-1941	117	35	30%	42	36%
	Total	212	93	44%	105	50%

607 cases were treated, in the six year period 1936-1941, 557 cases. In Stage I in the first period (216 cases) the five year cure rate is 71 per cent and the survival rate 72 per cent.

The corresponding numbers in the second period are 60 per cent and 66 per cent. The lower healing percentage in the second period is probably due to the fact that during this period cases, inoperable on admission, have become operable and have been operated upon.

In Stage II (391 patients from 1921-1935 and 354 from 1936-1941) the five year cure rate has risen from 24 per cent in the

of both the diagnosis and the classification. In the whole group the five year cure has risen from 40 per cent to 44 per cent and the survival rate from 44 per cent to 50 per cent.

A reliable comparison between the results in the preoperatively and postoperatively and only postoperatively treated cases is possible in the series from 1936-1941. In Stage I there is no difference in the survival rates between the preoperatively and postoperatively and the postoperatively only treated cases (66 per cent).

In Stage II, in contrast, the survival rate

TABLE IV
THE 451 CASES IN STAGE II (1936-1941) DIVIDED INTO THREE GROUPS
ACCORDING TO THE EXTENT OF AXILLARY METASTASES

	Postoperative Roentgen Treatment			Pre- and Postoperative Roentgen Treatment		
	No. of Cases	Survivals		No. of Cases	Survivals	
Group I (metastasis to one node)	18	13	72%	79	57	72%
Group II (metastases to several nodes)	69	27	39%	164	62	38%
Group III (periglandular infiltration in the axilla)	30	2	7%	91	29	37%

is 43 per cent in the preoperative and postoperative cases and 36 per cent in the postoperative, an improvement which is not statistically fully significant, but indicates the importance of the preoperative treatment.

Stronger evidence for this is given in the compilation in Table IV.

Stage II can be divided into the following three groups:

- Group I Cases with microscopically verified metastases to one lymph node.
- Group II Cases with metastases to two or more lymph nodes.
- Group III Cases where the tumor has grown through the capsule and infiltrates the connective and fatty tissue.

The survival rate in both Group I and II is approximately the same whether preoperative and postoperative radiation treatment was given or only postoperative treatment (Table IV).

In Group III, however, the survival rate in 30 patients who had been given solely postoperative radiation treatment is 6.7 per cent. In 91 patients who had been given both preoperative and postoperative radiation treatment, it is 31.9 per cent, a statistically significant improvement.

These findings strongly support the assumption that preoperative roentgen treatment greatly improves the prognosis in

cases where the cancerous growth has begun to invade the axillary tissue.

It cannot be sufficiently emphasized that it is not possible clinically to determine whether the growth is in Stage I or II. It is therefore imperative that all cases should be given preoperative roentgen treatment.

On comparing the results of the treatment in patients referred to us from different County Hospitals against those in patients referred to us from Karolinska Hospital interesting facts are revealed (Table V).

In the former group the survival rate in

TABLE V

FIVE YEAR RESULTS IN CASES OF CANCER OF THE BREAST TREATED BY ROENTGEN RADIATION PREOPERATIVELY AND POSTOPERATIVELY OR SOLELY POSTOPERATIVELY; 387 CASES REFERRED FROM THE SURGICAL MOTHER-CLINIC OF RADIUMHEMMET AND 298 REFERRED FROM COUNTY HOSPITALS

	Stages	No. of Cases	Survivals	
			Cases	Per Cent
Karolinska Hospital	I	133	107	80
	II	254	111	45
County Hospitals	I	165	90	55
	II	217	82	38

Stage I is 55 per cent and in the latter 80.4 per cent. In Stage II in the former it is 38 per cent and in the latter 45 per cent.

The healing percentage in the group from Karolinska Hospital is the most accurate expression of the prognosis in operable cases of cancer of the breast.*

Radiumhemmet
Stockholm, Sweden

REFERENCES

1. AHLBOM, H. Castration by roentgen rays as an auxiliary treatment in radiotherapy of cancer mammae at Radiumhemmet, Stockholm. *Acta radiol.*, 1930, *11*, 614-633.
2. AHLBOM, H. Preoperative roentgen treatment of mammary tumors at Radiumhemmet. *Acta chir. Scandinav.*, 1934, *74*, 474-476.
3. AHLBOM, H. Radiation treatment of cancer of the breast. *Nord. med.*, 1941, *12*, 3427.
4. BERVEN, E. Technique at Radiumhemmet in the treatment of tumours except cancer uteri. *Acta radiol.*, 1929, *10*, 3-48.
5. BERVEN, E. How can we improve the results of treatment of cancer of the breast? *Nord. med.*, 1946, *29*, 337.
6. FORSELL, G. On the permanency of radiological healing in malignant tumors. *Acta radiol.*, supp. II, 1928.
7. HANSSON, C. J. Results of pre- and postoperative treatment of cancer of the breast at Radiumhemmet. *Nord. med.*, 1940, *8*, 2739.
8. NOHRMAN, B. A. Results of treatment of cancer of the breast at Centrallasarettet in Borås, Sweden. *Acta radiol.*, 1943, *24*, 478-482.
9. NOHRMAN, B. A. Quelques expériences, tirées du traitement du cancer du sein par rayon X associés à l'opération d'Halsted. *J. de radiol. et d'électrol.*, 1948, *29*, 403.
10. NOHRMAN, B. A. Cancer of the breast. *Acta radiol.*, supp. LXXVII, 1949.
11. WESTERMARK, N. Result of combined surgical and radiological treatment of cancer mammae at Radiumhemmet 1921-1923. *Acta radiol.*, 1930, *11*, 1-32.

* For discussion see page 349.



TREATMENT AND RESULTS IN CANCER OF THE BREAST*

By SIR STANFORD CADE, K.B.E., C.B., F.R.C.S.

Surgeon, Westminster Hospital, Mount Vernon Hospital and the Radium Institute
LONDON, ENGLAND

SUCCESS or failure in treatment of cancer of the breast depends mainly on two factors: (1) the stage of the disease when treatment is undertaken; (2) the quality of the treatment. These two factors will be considered separately and in their relation to each other.

STAGE OF THE DISEASE

With minor modifications, U. V. Portmann's classification has been adopted. It is as follows.

- Stage I Tumor of the breast only.
- Stage II Tumor of the breast plus skin changes and/or axillary lymph nodes.
- Stage III Tumor of the breast plus supraclavicular lymph nodes or contralateral axillary lymph nodes or fixation to pectoral fascia.
- Stage IV Skeletal or visceral metastasis.

This staging is a clinical one, as it must be, if the choice of method of treatment and technique are to be based on it. Amplification of the significance of the staging is of importance. It is admitted that not all axillary lymph nodes containing metastasis are clinically palpable; conversely a few palpable axillary nodes prove subsequently to be free from metastasis. But if Stage I is a strictly clinical stage, it is limited to the earliest cases with the best prognosis, providing the best treatment is given.

Stage II includes various types of skin involvement. These can be subdivided into three main groups: (1) When the tumor is adherent to the overlying skin; this group varies from mere puckering of the skin over the tumor to fungation through the skin, but at both extremes it is a direct spread of the tumor outwards. (2) When the skin is edematous, the "peau d'orange" or pig-

skin type; it indicates lymphatic blockage and spread of disease by lymphatic invasion; it is a much graver clinical sign than direct spread. (3) The discrete skin nodules; these vary from one or two to numerous and widespread distribution of nodules. It is an indication that the disease has metastasized widely and is quite unsuitable for any form of surgical treatment.

Stage III includes the patient with supraclavicular or contralateral lymph nodes. This indicates that the disease is outside the anatomical field covered by radical mastectomy. Stage III also includes cases where the tumor is fixed to the pectoral fascia and hence beyond surgery.

QUALITY OF TREATMENT

There are two main therapeutic measures, surgery and radiotherapy. The general principles of surgery in cancer must be applied to the surgical treatment of breast cancer. These principles are well known and need not be reiterated here; these principles dictate the performance of a radical mastectomy. Simple mastectomy is unsound and only justifiable as a palliative measure in a small group of cases, where radical mastectomy is not indicated. Simple mastectomy by itself very seldom cures the patient. It leaves untouched the very site which determines the patient's future—axillary nodes.

Radiotherapy. Both radium and roentgen rays can be used with success. The technique of roentgen irradiation is simpler and more convenient to the patient. As practiced at Westminster Hospital it can be summarized as follows: 200-220 kv.; half-value layer 2.2 mm. copper; target skin distance 40-50 cm.; filtration 2.0 mm. of copper or Thoraeus filter. In most cases the

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

roentgen-ray beams are directed to the three sides of a triangular space in such a way that maximum uniformity of dosage is achieved throughout the volume treated; this volume includes the breast and the axilla and the chest wall on the side treated. The duration of the treatment is four to five weeks and the average total tumor dose is 3,500 roentgens.

When radium is used, either the interstitial or surface methods are employed. In the former a systematic needling of the breast, axilla and supraclavicular and infraclavicular areas is carried out. Long low intensity needles are used; a total of 75 to 100 mg. is needed and the duration of treatment is seven days continuous irradiation. With surface radiation a sorbo rubber

TABLE I
CANCER OF THE BREAST, 348 CASES

	Total Number	Percentage of Survivals Free from Disease		
		Years		
		5	10	15
Stage I	97	87	65	36
Stage II	138	29	25	12
Stage III	95	20	15	7
Stage IV	18	0	0	0

treatment. Further there is statistical evidence that preoperative irradiation gives improved long term results. Postoperative irradiation in Stage I cases has not improved the results achieved by radical surgery

TABLE II
CANCER OF THE BREAST 1932-1938: 263 CASES: 5 AND 10 YEAR SURVIVALS

	Surgery		Radium		Surgery + Radium	
	Years		Years		Years	
	5	10	5	10	5	10
Stage I	87%	65%	70%	60%	78%	63%
Stage II	29%	25%	25%	21%	35%	32%
Stage III	9%	7%	15%	13%	10%	9%

plaque is made to fit the chest wall and the radium is distributed on it according to the Manchester distribution rules. Treatment is intermittent, twelve hours daily over a period of three to four weeks. The only advantage of radium over roentgen rays is the greater tissue dose achieved, namely 6,000 to 9,000 gamma roentgens. The majority of cases are treated by roentgen irradiation and only a few selected cases by radium.

Choice of Method of Treatment. The distinction of preoperative and postoperative radiotherapy is quite clear. Radiotherapy adequately given leads to clinical regression of the tumor. There is ample histopathological evidence that total disappearance of the tumor can be so achieved. It is the permanency of such regression which cannot be forecast. On common sense grounds, it is obvious that preoperative irradiation is of greater value than postoperative

alone, namely 65 to 75 per cent of ten year survivals. The choice of treatment can be summarized as follows.

Stage I—Radical surgery.

Stage II—Preoperative radiotherapy and radical surgery.

Stage III—Radiotherapy only.

It must be emphasized that surgery in Stage III is not warranted and often leads to more rapid progress of the disease than if no treatment were given.

This review is based on a total of 915 cases of cancer of the breast treated personally since 1924; of these, 348 cases lend themselves to a fifteen year survey (Table I) and 263 cases to an analysis according to the method of treatment (Table II).*

Westminster Hospital
London, England

* For discussion see page 349.

THE TREATMENT AND RESULTS IN CANCER OF THE BREAST AT THE PRESBYTERIAN HOSPITAL, NEW YORK*

By C. D. HAAGENSEN, M.D.

NEW YORK, NEW YORK

DURING the past twenty-five years, at the Presbyterian Hospital in New York, there has been a trend toward a more radical surgical attack upon cancer of the breast. Our reliance upon irradiation for the cure of the disease has faltered, until we have come to the point where we reserve irradiation for cases in which palliation is all that can be hoped for. Looking backward, there are two factors which have led us toward more radical surgery and away from irradiation.

The first reason has to do with the fact that the Presbyterian Hospital is one of several American teaching hospitals where generous provision of facilities and funds has made the Halsted type of surgery possible. By the Halsted type of surgery we mean meticulous dissection, with exact hemostasis and gentle handling of tissues, usually with silk technique. With this type of surgery it is possible to carry out more thorough dissections in which a great deal more tissue is removed. Radical mastectomy, for instance, when done in this truly radical manner, requires between five and six hours to carry out. The fact that we have had the privilege of working in a hospital where we have been permitted to indulge a desire for thoroughness has, of course, enabled us to carry out methods which might not be practical in all hospitals.

A second factor that influenced us toward surgery rather than irradiation was our experience in an experimental series of cases in which Dr. Lenz, Dr. Stout and I attempted to destroy cancer of the breast with intensive irradiation.⁸

In a total of 38 cases treated between

1933 and 1937, intensive protracted roentgen treatment was given. Dr. Lenz has described his methods elsewhere. The fractional dose method was used, 100 to 200 roentgens being given daily to each of one or more portals. The breast was treated through four portals directed tangentially to the chest wall, and often through an additional portal directly over the tumor. The axilla and supraclavicular regions were treated through an anterior and a posterior portal and through a third axillary portal. The tumor dose to the primary lesion of the breast reached 4,500 r. Two or more months were required for the treatment. After a delay of at least another month for the severe cutaneous reaction to subside, radical mastectomy was done. In every case in the series, persisting carcinoma cells were found in the microscopical studies. Although the cancer cells were usually damaged by the irradiation, they were not all destroyed. Metastases in axillary lymph nodes seemed to be more resistant than the primary growth. The details of the histopathological findings in representative cases in the series were reported by Beach.² This experience discouraged us in our hope of curing cancer of the breast with irradiation and led us toward reliance solely upon surgery.

If these heroic doses of radiation fail to cure, the much smaller ones given in the usual prophylactic preoperative or postoperative irradiation would seem futile and we have therefore given up prophylactic irradiation. This failure of irradiation as a curative agent has in no way lessened our reliance upon irradiation for palliation, where it is of inestimable value.

* From the Department of Surgery of the Presbyterian Hospital, and the Laboratory of Surgical Pathology, Columbia University. Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

SELECTION OF CASES FOR OPERATION

When we came to realize that in our hands surgery was our sole reliance for the *cure* of cancer of the breast, we sought to improve our surgical attack. The first step in this direction was to select our patients for operation more critically.

In the Presbyterian Hospital, as in a good many others, certain surgeons had been accustomed to operate upon almost every case of cancer of the breast applying for treatment, no matter how advanced it might be, with the faint hope that cure might be achieved. From observing results of this kind of desperate surgery, we learned that patients with certain clinical forms of the disease are never cured, no matter how radical the operation. Dr. Stout and I set out to try to define, from the records of our hospital, which were exceptionally complete, just which types of cases had been cured by operation. We used the punch card method in studying our data, which made it possible to correlate the five year cure rate and the local recurrence rate with a whole series of clinical features of cancer of the breast as recorded in our series of cases. Our first study, presented in 1942,³ included a total of 876 primary cases coming to the Presbyterian Hospital between 1915 and 1934, inclusive. In 640, or 73.1 per cent, radical mastectomy was done.

To illustrate the way in which we studied the prognostic significance of the various clinical signs of the disease, we might describe our findings as regards edema of the skin. Edema develops when the subdermal lymphatics are blocked by carcinoma emboli. This fact explains why edema is such a grave sign. Actually, we found that not a single one of 41 patients, in whom one-third or more of the skin over the breast showed edema, was cured by radical mastectomy. The local recurrence rate in these 41 patients was 66 per cent.

From our studies we worked out the following rule for judging operability in carcinoma of the breast.^{4,5}

Women of all age groups who are in good

enough general condition to run the risk of major surgery should be treated by radical mastectomy, except as follows: (1) when the carcinoma is one which developed during pregnancy or lactation; (2) when extensive edema of the skin over the breast is present; (3) when satellite nodules are present in the skin over the breast; (4) when intercostal or parasternal tumor nodules are present; (5) when there is edema of the arm; (6) when proved supraclavicular metastases are demonstrated; (7) when the carcinoma is the inflammatory type; (8) when distant metastases are demonstrated; (9) when any two, or more, of the following signs of locally advanced carcinoma are present: (a) ulceration of the skin; (b) edema of the skin of limited extent (less than one-third of the skin over the breast involved); (c) solid fixation of the tumor to the chest wall; (d) axillary lymph nodes measuring 2.5 cm. or more, in transverse diameter, and proved to contain metastases by biopsy, and (e) fixation of axillary lymph nodes to the skin or the deep structures of the axilla.

If these criteria had actually been followed in selecting the patients for operation in our 1915-1934 Presbyterian Hospital series of 640 radical mastectomies, a total of 109 would not have been operated on. Yet the number of patients permanently cured would not have been decreased by a single one.

We have followed this rule for judging operability more or less consistently during recent years at the Presbyterian Hospital, and we have found that it is surprisingly reliable. When we have overstepped these contraindications to operation, as any surgeon is frequently tempted to do, we have not obtained cure in any case.

We have recently completed a review of the 1935 to 1942 (inclusive) cases of cancer of the breast coming to the Presbyterian Hospital. There were 668 primary cases. In 495, or 74.1 per cent, radical mastectomy was carried out. Twenty-five of these patients had inoperable disease ac-

according to our criteria. Not one of them was cured in five years, and 10, or 40 per cent, developed local recurrence.

Our rule has also been tested by application to the records of the Hartford Hospital¹⁰ and the Barnard Free Skin and Cancer Hospital.⁹ In both clinics it has been found to hold true, except for its first category the cases in which carcinoma developed during pregnancy or lactation. Each of these two clinics has 2 patients in this category cured for more than five years by operation. Although the evidence is all too clear that carcinoma of the breast developing during pregnancy or lactation is an especially malignant type, we now are inclined to modify our position and to consider operation in less advanced cases of this type.

A MORE RADICAL MASTECTOMY

While learning to select our patients more critically for operation, we have tried to extend the scope and to improve the technique of our operative procedure.⁵ Following the general plan of the traditional Halsted operation, we remove as much tissue from the chest wall and axilla as we dare, without unreasonable danger to the patient's life or interference with arm function. Our skin incision is planned solely from the viewpoint of adequate removal of the suspected tissues, and so much skin is sacrificed that a skin graft is almost always required to cover the defect remaining on the chest wall. Our skin flaps are cut thinner than in the usual so-called radical mastectomy, and include only the skin itself with its dermal glands and small blood vessels, and the thin layer of fat and areolar tissue lying superficial to the superficial layer of the superficial fascia. Both pectoral muscles, in their entirety, are removed. Traction upon the breast as it is being dissected off of the chest wall is avoided. The axilla is dissected meticulously, usually sacrificing the thoracodorsal vessels and nerve.

With proper attention to the details of technique which insure good wound healing—gentleness in handling tissues, careful

hemostasis, and the avoidance of tension in suturing the skin flaps—our technique does not have an added morbidity or mortality, as compared with less radical operations. Edema of the arm rarely develops, and when it does occur, it has not been severe. Indeed, it is less troublesome in our patients than in those of some other surgeons who carry out less radical dissections with a less meticulous technique and obtain poor wound healing. Edema of the arm is due to the fibrosis which follows imperfect wound healing, and is not dependent upon the degree of radicalness of the operation.

OUR RESULTS

We present our most recent results in cancer of the breast at the Presbyterian Hospital (Table I). They include the 668 primary cases in the records of the hospital between 1935 and 1942, inclusive. Radical mastectomy was done in 495, that is 74.1 per cent. A score of different surgeons, using varying techniques, performed the operations.

The *absolute* five year survival rate was 47.2 per cent and the absolute five year cure rate 38.6 per cent.

In Table II these results are detailed. The *relative* five year survival rate is seen to be 58.2 per cent and the relative five year cure rate is 48.7 per cent. Local recurrence—including all instances of reappearance of this disease in the operative field in the chest wall and axilla—developed in 14.5 per cent.

Table III shows our results according to the extent of the disease. In 94.9 per cent of the cases treated by radical mastectomy, the disease was operable according to our criteria. In these operable cases the five year cure rate was 71.8 per cent when the axillary nodes were not involved, but it fell to 37.8 per cent when axillary metastases were present.

The results are noteworthy in a group of 25 cases in which the disease was inoperable according to our criteria, yet radical mastectomy was done. Only one of these patients survived as long as five years,

and the local recurrence rate was 40 per cent.

I should also like to present the results (Table IV) in a smaller personal series of cases of cancer of the breast in which my

year cure rate was 59 per cent. It is important to point out that in the group of cases in which the disease was limited to the breast 90 per cent were well after five years and none had developed local recur-

TABLE I

Presbyterian Hospital 1935-1942 (inclusive)

I. Total number of female patients with mammary cancer	787
II. <i>Secondary</i> cases—previous curative treatment elsewhere	119
III. <i>Primary</i> cases—no previous curative treatment	668
Ward—411	Private—257
a—No irradiation or surgery	37
b—Irradiation only	107
c—Irradiation followed by simple mastectomy	4
d—Local excision or partial mastectomy	5
e—Simple mastectomy	13
f—Simple mastectomy plus axillary dissection	7
g—Radical mastectomy	495, or 74.1%
h—Total cases receiving treatment	631, or 94.5%

Absolute Survival and Cure Rates

In calculating absolute cure and survival rates *no* deductions from the total number of primary cases are made.

IV. <i>Absolute</i> 5 year survival rate ($315 \div 668$)	47.2%
V. <i>Absolute</i> 5 year clinical cure rate ($258 \div 668$)	38.6%

TABLE II

Presbyterian Hospital 1935-1942 (inclusive)

Five Year Results with Radical Mastectomy

I. Number of radical mastectomies	495
II. Operative deaths	9, or 1.8%
III. Lost track of before 5 years	19, or 3.8%
Ward cases—2	Private cases—17
IV. Died of unknown cause before 5 years	7, or 1.4%
V. Died of intercurrent disease before 5 years	18, or 3.6%
VI. Died of breast cancer before 5 years	154, or 31.1%
VII. Alive with breast cancer persisting 5 years after operation	47, or 9.5%
VIII. Alive without breast cancer 5 years after operation	241, or 48.7%

Relative Survival and Cure Rates

In calculating relative survival and cure rates *no* deductions from the total number of patients operated upon are made.

Patients lost track of, or dying of intercurrent disease before 5 years are counted as dead of breast cancer.

Relative 5 year survival rate ($288 \div 495$)	58.2%
Relative 5 year clinical cure rate ($241 \div 495$)	48.7%
Local recurrence rate ($72 \div 495$)	14.5%
1—on chest wall ($69 \div 495$)	13.9%
2—in axilla ($11 \div 495$)	2.2%

own technique for radical mastectomy was carried out, usually with a resident surgeon operating and myself assisting him. In this group of 103 operable cases there were no operative deaths, and the relative five

year cure rate was 59 per cent. This illustrates what can be achieved when a thorough operation is carried out for the so-called Stage 1 cases. I doubt that irradiation can achieve a higher cure rate, and I know that the morbidity in terms

TABLE III

Presbyterian Hospital 1935-1942 (inclusive)	
Five year results with radical mastectomy according to extent of disease	
A—Cases classed as operable (Haagensen and Stout)	470, or 94.9%
(1) Limited to breast	189, or 40.2%
a—Number of patients surviving 5 years	144, or 76.6%
b—Number of patients cured 5 years	135, or 71.8%
c—Number developing local recurrence	8, or 4.3%
(2) Breast and axilla involved	281, or 59.8%
a—Number of patients surviving 5 years	143, or 51.1%
b—Number of patients cured 5 years	106, or 37.8%
c—Number developing local recurrence	54, or 19.2%
B—Cases classed as inoperable (Haagensen and Stout)	25, or 5.1%
a—Number of patients surviving 5 years	1, or 4.0%
b—Number of patients cured 5 years	0
c—Number developing local recurrence	10, or 40.0%

TABLE IV

Personal Series—Presbyterian Hospital 1935-1942 (inclusive)	
Radical Mastectomies—Resident Surgeon Operators	
A—Cases classed as operable	103
(1) Limited to breast	40, or 38.8%
a—Number of patients surviving 5 years	37, or 92.5%
b—Number of patients cured 5 years	36, or 90%
c—Local recurrence	0
(2) Breast and axilla involved	63, or 61.2%
a—Number of patients surviving 5 years	32, or 50.8%
b—Number of patients cured 5 years	26, or 41.3%
c—Number developing local recurrence	12, or 19%
B—Cases classed as inoperable	2
Case No. 461444—Brain metastasis mistaken for pituitary adenoma. Died 14 months after operation without local recurrence.	
Case No. 74983—Extensive edema of skin. Local recurrence and pulmonary metastases. Died 14 months.	
Relative 5 year survival rate (69 ÷ 105)	65.7%
Relative 5 year cure rate (62 ÷ 105)	59%

TABLE V

PRESBYTERIAN HOSPITAL SERIES 1935-1942 (INCLUSIVE). RESULTS OF RADICAL MASTECTOMY
ACCORDING TO LENGTH OF OPERATION

Length of Operation in Minutes	No. of Cases	Operative Deaths		5 Year Local Recurrence		5 Year Clinical Cure	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
I. 1 to 59 min.	0						
II. 60-119 min.	17	1	5.9	4	23.5	4	23.5
III. 120-179 min.	74	2	2.7	11	14.9	33	44.6
IV. 180-239 min.	145	2	1.4	21	14.5	67	46.2
V. 240 or more min.	259	4	1.5	36	13.9	137	52.9

of edema of the arm and limitation of arm function is greater after intensive irradiation than after a satisfactory operation.

Table v presents interesting data which support the advantageousness of a thorough operation. As the length of time devoted to the operation increased in patients operated upon between 1935 and 1942, the cure rate rose and the frequency of local recurrence fell.

A final point to be emphasized regarding our results with cancer of the breast is that they have steadily improved during the last generation. In Table vi the results with

lished in 1902, outlined the standards for evaluating the results of the treatment of cancer which should be our guide. Except for the League of Nations Committee of European gynecologists and radiologists who in 1928⁷ undertook to study the end-results of treatment of cancer of the uterus, very few have followed Winter's method of expressing results in terms of the *absolute*, or over-all cure rates. The absolute five year cure rate is the percentage of the total number of new patients with cancer applying for treatment who are known to be clinically well five years later. The absolute

TABLE VI

PRESBYTERIAN HOSPITAL SERIES—1935-1942 (INCLUSIVE). RESULTS OF RADICAL MASTECTOMY ACCORDING TO FIVE YEAR PERIODS

	No. of Cases	Operative Deaths		5 Year Local Recurrence		5 Year Clinical Cure	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
I. 1915-1919	128	3	2.3	32	25.0	34	26.6
II. 1920-1924	127	7	5.5	24	18.9	37	29.1
III. 1925-1929	160	8	5.0	42	26.3	53	33.1
IV. 1930-1934	225	2	0.9	48	21.3	107	47.6
V. 1935-1939	314	5	1.6	52	16.6	146	46.5
VI. 1940-41, 42	181	4	2.2	20	11.0	95	52.5

radical mastectomy in our hospital are shown grouped in five year periods from 1915 to 1942. It will be seen that the cure rate has doubled since 1915. This improvement appears to have been achieved without the assistance of irradiation, for we have used it but little during recent years. A more critical selection of cases for operation is no doubt the main factor in this improvement in our relative cure rate.

ABSOLUTE CURE RATES

In this symposium we are comparing the results of the treatment of cancer of the breast in several American and foreign clinics. It is at once apparent that a strict comparison of our results is impossible because the cure rates have been compiled in different ways. The unpleasant truth is that almost a half century has gone by since Winter,¹¹ in a memorable paper pub-

lished in 1902, outlined the standards for evaluating the results of the treatment of cancer which should be our guide. Except for the League of Nations Committee of European gynecologists and radiologists who in 1928⁷ undertook to study the end-results of treatment of cancer of the uterus, very few have followed Winter's method of expressing results in terms of the *absolute*, or over-all cure rates. The absolute five year cure rate is the percentage of the total number of new patients with cancer applying for treatment who are known to be clinically well five years later. The absolute

five year survival rate is also a useful figure, and refers, of course, to the percentage of the total number of new patients with cancer who survive five years. Until we all present our results with cancer of the breast in these terms, it will be impossible to decide which method of treatment is the best. *Relative* five year cure and survival rates, which represent the percentage of patients cured or surviving of the total number treated are of less importance for comparison, because these relative rates are influenced by the selection of patients for treatment. They should, however, be included in all studies of end results.

In compiling our results of treatment of the breast cancers seen at the Presbyterian Hospital between 1915 and 1934, Dr. Stout and I presented absolute as well as relative cure and survival rates, and we have again presented them today for our latest series

of cases, those seen between 1935 and 1942, inclusive.

The League of Nations Committee to which I have referred specified in detail the standards to be used in compiling results of treatment. An important feature of the method recommended is the use of the *total number* of cases in which treatment is undertaken as a basic figure in compiling the results. *No deductions* are permitted for patients failing to complete treatment, or lost to follow-up, or dying of intercurrent disease or unknown cause, within the five year period. All patients in these categories, even if free of clinical evidence of cancer at the time they are lost sight of, or die, must be counted as having died of cancer.

In determining our end results at the Presbyterian Hospital, Dr. Stout and I have followed these standards with care. As will be seen in Table II no deductions from the total number of patients operated upon have been made. In certain other clinics very different methods of compiling end results have been used. Deductions of various groups of cases from the total number treated have been made, thus favorably influencing the cure rate. Adair,¹ in his last comprehensive report of the end results of the treatment of cancer of the breast at the Memorial Hospital (1943) used a method of compiling end results in which he divided his patients into indeterminate and determinate groups. Some 613 patients of a total of 1,996 primary operable cases were placed in the indeterminate group. These 613 cases, which included the patients lost to follow-up, those dying of intercurrent disease before five years, and those in which satisfactory microscopical evidence was not available, were set aside as "not available for exact studies" and were not considered in calculating the cure rate! This concept of an "indeterminate" group of cases seems to us to be basically incorrect. *All* cases are determinate in that they represent the sum total of the curative achievement of the hospital's forces in combatting the disease.

The confusion which results from the use of such widely divergent methods of com-

paring cure rates is like that which would follow if each one of us calculated his income tax on the basis of an individual method.

In all humility we must realize that our duty to society necessitates the general use of the strictest standards for studying the end results of treatment. The truth is difficult enough to discern even when we discipline ourselves with the most rigorous safeguards against statistical error.

I would appeal for a strict comparison of absolute cure and survival rates, with the hope that with such data we can justly compare the relative merits of different methods of treatment. Only in this way can we hope to find out how best to treat cancer of the breast.*

622 West 168th St.
New York 32, New York

REFERENCES

1. ADAIR, F. E. Role of surgery and irradiation in cancer of the breast. *J.A.M.A.*, 1943, 121, 553-559.
2. BEACH, A. Effects of roentgen-ray dosage in breast carcinoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 46, 89-95.
3. HAAGENSEN, C. D., and STOUT, A. P. Carcinoma of the breast; results of treatment. *Ann. Surg.*, 1942, 116, 801-815.
4. HAAGENSEN, C. D., and STOUT, A. P. Carcinoma of the breast; criteria of operability. *Ann. Surg.*, 1943, 118, 859-870; 1032-1051.
5. HAAGENSEN, C. D. Symposium on cancer of the breast; technique for radical mastectomy. *Surgery*, 1946, 19, 100-131.
6. HAAGENSEN, C. D. Carcinoma of the breast. *J.A.M.A.*, 1948, 138, 195-205; 279-292.
7. League of Nations. Health Organization, Cancer Commission. Report submitted by the Radiological Sub-commission, Geneva, 1929, p. 14.
8. LENZ, M. Tumor dosage and results in roentgen therapy of the breast. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 56, 67-74.
9. TOMLINSON, W. L., and ECKERT, C. Personal communication to the author.
10. WELLS, D. B. An audit of experience with breast cancer at the Hartford Hospital 1932-1939. Presented at a meeting of the New England Surgical Society in Boston, February 6, 1946.
11. WINTER, G. Ueber die Principien der Carcinomstatistik. *Centralbl. f. Gynäk.*, 1902, 26, 81.

* For discussion see page 349.

CANCER OF THE BREAST*

By DR. ROBERT McWHIRTER

Royal Infirmary

EDINBURGH, SCOTLAND

BEFORE proceeding to give an account of the method of treatment now in use in Edinburgh, perhaps I may be permitted to make some observations which have an important bearing on this discussion.

Cancer of the breast is a common disease and great interest has been taken in its treatment for many years. By using reliable methods of assessment we ought to know by now the true value of each method of treatment and which method will give the best results. The very fact that we do not know is surely a clear indication that our methods of assessment are faulty. Faulty assessments produce great confusion and it is regrettable that it should still be possible to select from the most recent publications evidence which will either support or condemn any method of treatment we care to consider. Each year further contributions are added to this bewildering array, and the competition to produce still higher survival rates continues. That such confusion should exist is a serious matter, for progress is retarded and patients may not always be treated by the method which gives the best results.

We have it in our power to end this state of affairs, and because radiotherapists are so frequently concerned with this problem, I venture to suggest to this meeting that we should take the opportunity at the next International Congress of Radiology to discuss the manner in which results should be presented. If we are successful in this, there is not the slightest doubt that we will render great service not only to ourselves but also to our patients.

More extensive observations have been made elsewhere and time does not permit of their repetition, but briefly it may be said that many authors in presenting their

results have failed to appreciate the extent by which selection may distort the value of a method of treatment. Thus, in many publications only the results of cases actually treated are presented and the number of untreated cases may never even be mentioned. Yet it will be agreed that the more carefully patients are selected for treatment the higher will be the survival rates in the treated cases. Even with a poor method of treatment good results in treated cases can always be obtained provided only early cases are selected. These observations are beyond dispute and yet it is this failure to appreciate the influence of selection which causes so much of the present confusion.

It must not be assumed from what has been said that it is wrong to select patients for a method of treatment. Indeed, the reverse is true and we are indebted to Haagensen and Stout for the good service they have done in demonstrating that radical mastectomy when performed in certain types of cases may not only shorten life but may also make the end more miserable. At the same time it is most essential to appreciate that this improved selection, while inevitably providing higher five year survival rates in treated cases, will not save the life of a single additional patient.

It cannot be too strongly emphasized that the true value of a method of treatment depends just as much on the number of cases to which it will apply as on the results obtained when it is applied. Cases considered to be beyond a method of treatment are just as much failures as cases actually treated and failing to be cured. If we wish to avoid the distorting influence of selection we must accept that the only really reliable survival rates are those obtained by expressing the number of survivors as a per-

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

centage of the total cases referred. No case must be omitted from this total for any reason whatsoever. Patients who were never admitted to hospital and advanced cases admitted to medical wards for the treatment of pleural effusions, jaundice, cerebral metastases, etc., must still be included in the total on which the survival rate is based.

It is admitted that the proportion of advanced cases will vary from one hospital to another, but it is difficult to see how proper allowance can be made for this. Attempts have been made to overcome this difficulty by means of staging, but of all the methods of staging none are free from variation in interpretation. The same is true of the criteria of operability, for no matter how carefully these are defined, they will always be subject to so much personal variation in interpretation that reliable comparison on the basis of operable cases cannot be made.

Exception, too, must be taken to comparisons by means of "clinical cure rates" or "symptom-free rates." It is necessary to recall that many of these assessments may depend on the statements made by the patient or by the family physician, and that even when the clinical examination is conducted at the clinic it may be extremely difficult to tell whether a patient is free from disease or not. "Clinical cure rates" and "symptom-free rates" cannot be regarded as other than statements of opinion. Survival rates, which are statements of fact, are therefore preferable.

It may also be observed that when the results of treatment are based on all cases coming to a large general hospital, they are of greater value than those obtained in special hospitals and much more reliable than the results of a personal series recorded by individual surgeons.

The adoption of the above basis of assessment will provide results which may come as a great disappointment to those who in the past have been content to calculate the survival rates of only those cases which were fully treated.

Thus while five year survival rates vary-

ing (according to the degree of selection) from 35 per cent to 45 per cent may be obtained in cases actually treated by radical mastectomy, I do not believe the five year survival rate will exceed 25 per cent when all cases referred to a large general hospital are included in the total on which the survival rate is based.

Put in another way, the radical operation fails in approximately 75 per cent of cases as judged by the five year survival rate. It was because radical mastectomy was recognized to fail in so many cases that it was decided in Edinburgh to explore the value of other methods of treatment.

The value of combining postoperative radiotherapy with radical mastectomy was first investigated. Table I shows the results obtained and it will be noted that the five year survival rate of all cases was 30.9 per cent. The investigation began in 1935 and was continued until 1940.

TABLE I*

DATA FOR YEARS 1935-1940

- I. Total number of cases coming to the clinic with breast carcinoma was 932 and of this number 784 were primary cases.
- II. Number of primary cases—untreated—130. Of this number 49 had no treatment at all and, in a further 81 patients who had distant metastases when they were first seen, the treatment was directed mainly to the metastases.
- III. Number of primary cases—treated—654.
 - A. The number of cases classified as inoperable was 141.
 - a. Number of patients surviving at the end of five years = 9—6.4 per cent.
 - b. Number of patients clinically cured at the end of five years = 6—4.3 per cent.
 - B. Number of patients classified as operable = 513.
 - a. Number of patients surviving at the end of five years = 230—44.8 per cent.
 - b. Number of patients clinically cured at the end of five years = 203—39.5 per cent.

Of the 784 patients with primary tumors 242 were alive at the end of five years—30.9 per cent.

All deaths have been assumed to be due to cancer.

While postoperative radiotherapy was successful in reducing the number of local

* The data in Tables I and II have been presented in accordance with the request made by the American Radium Society.

recurrences, many patients continued to die of distant metastases. This led to the belief that dissection of the axilla might cause dissemination of malignant cells to sites beyond the area which could be irradiated. It will be appreciated that if cells are in fact disseminated then postoperative radiotherapy will fail to save the life of the patient, for no matter how effective it is locally it cannot influence cells outside the irradiated area.

In 1941 the treatment of breast cancer was discussed at a further meeting of the surgical staff and it was decided to continue to remove the breast by surgery but that the treatment of the axilla should be by radiotherapy alone. This decision was made for the following reasons:

1. When the disease is confined to the breast, surgery gives good results. Surgery is thus an effective method of treating the disease in the breast, and it was decided that surgical removal should be continued.

2. While at first sight surgery might appear to be the most satisfactory method of treating the axilla, a more careful examination will show that its value is, in fact, very limited. It is true that the results are excellent when the axillary glands are not involved, but if there are no malignant cells in the axilla it would appear unnecessary to dissect it, for the removal of normal lymph nodes cannot influence the result. On the other hand, when the axilla is secondarily involved, there is universal agreement that radical mastectomy often fails to save the life of the patient. Since, therefore, surgical removal of the lymph nodes is unnecessary when the axilla is not involved and often fails when the axilla is involved, it was decided to treat the axilla by radiotherapy to see if better results could be obtained.

3. In many forms of cancer radiotherapy has now become the treatment of choice, and in breast carcinoma it has been shown that postoperative recurrences can be effectively treated by this means. Immediate postoperative radiotherapy will greatly reduce the number of local recurrences. From these observations it must be concluded

that radiotherapy can destroy breast cancer cells and that radiotherapy is at least an alternative method of treating the axilla.

Soon after this method of treatment was introduced it was found that a much higher proportion of patients could be given full treatment than had been possible before. Thus the prospect of cure was offered to a greater number of patients, and, as will be shown later, patients with fixed axillary glands and with glands present in the supraclavicular region were treated with a considerable measure of success.

The wound heals more quickly than after the radical operation. Radiotherapy can, therefore, be applied with less delay, and the interval during which cells may escape to distant sites is thus reduced.

When patients are treated by radical mastectomy and radiotherapy, edema of the arm is common. With simple mastectomy and radiotherapy edema of the arm is almost unknown.

The number of survivors at the end of five years has now been ascertained for the years 1941 and 1942, during which 480 new primary cases were referred. The results are presented in Table II.

TABLE II

DATA FOR YEARS 1941 AND 1942

- I. Total number of cases coming to the clinic with breast carcinoma was 521, of which 480 were primary cases.
- II. Number of primary cases—untreated = 72. Of this number 21 had no treatment at all and in a further 51 patients who had distant metastases when they were first seen, the treatment was directed mainly to the metastases.
- III. Number of primary cases—treated = 408.
 - A. Number of cases classified as inoperable = 98.
 - a. Number of patients surviving at the end of five years = 18—18.3 per cent.
 - b. Number of patients clinically cured at the end of five years = 16—16.3 per cent.
 - B. Number of cases classified as operable = 310.
 - a. Number of patients surviving at the end of five years = 175—56.5 per cent.
 - b. Number of patients clinically cured at the end of five years = 152—49.0 per cent.

Of the 480 patients with primary tumors, 197 were alive at the end of five years—41 per cent.

All deaths have been assumed to be due to cancer.

Not only is the survival rate high in the operable cases, but it will also be observed that 18.3 per cent of the cases classified as inoperable (according to the standard laid down by Haagensen and Stout) are alive at the end of five years. This remarkably high figure clearly demonstrates that radiotherapy is an effective method of treatment of the axilla even when the axillary involvement is gross.

Attention is drawn to the fact that the number of patients referred each year is much higher than in the period 1935-1940. Since 1941 an attempt has been made to

Royal Infirmary. All or nearly all patients must be referred for several years before such a high percentage is obtained, and it may therefore be assumed that nearly all cases of breast cancer occurring in south-east Scotland are now being referred to the Royal Infirmary. From these observations it can be claimed with considerable confidence that the results obtained during the period 1941-1942 are based on unselected cases. In all probability the results are less influenced by selection than any figures hitherto published. It is almost superfluous to add that if the referral of all advanced cases had not been especially requested, still higher survival rates could have been presented.

A full account cannot be given of all the technical details of treatment by simple mastectomy and radiotherapy and the following is a brief summary of the essential points.

The method of treatment is a combination of two procedures which must be co-ordinated if the best result is to be obtained.

The following points are of importance in the surgical aspect of treatment.

1. Preoperative preparation by iodine is contraindicated because it lowers the skin tolerance to radiotherapy.

2. The skin incision and the undermining of the skin flaps should be as limited as possible, so that tissue spaces outside the area to be irradiated will not be contaminated with malignant cells liberated during the operation.

3. Excessive skin should not be removed for tension on the skin flaps may be associated with failure of the wound to heal and delay in the application of radiotherapy. Tightly stretched skin flaps do not tolerate irradiation well. Skin grafting does not overcome the difficulty, for grafts do not tolerate roentgen treatment well.

4. Where the primary tumor is mobile on the pectoral fascia, the fascia should not be removed as this promotes fibrosis of the pectoral muscle. If the tumor is firmly fixed to the pectoralis major, the muscle should be removed together with the breast.

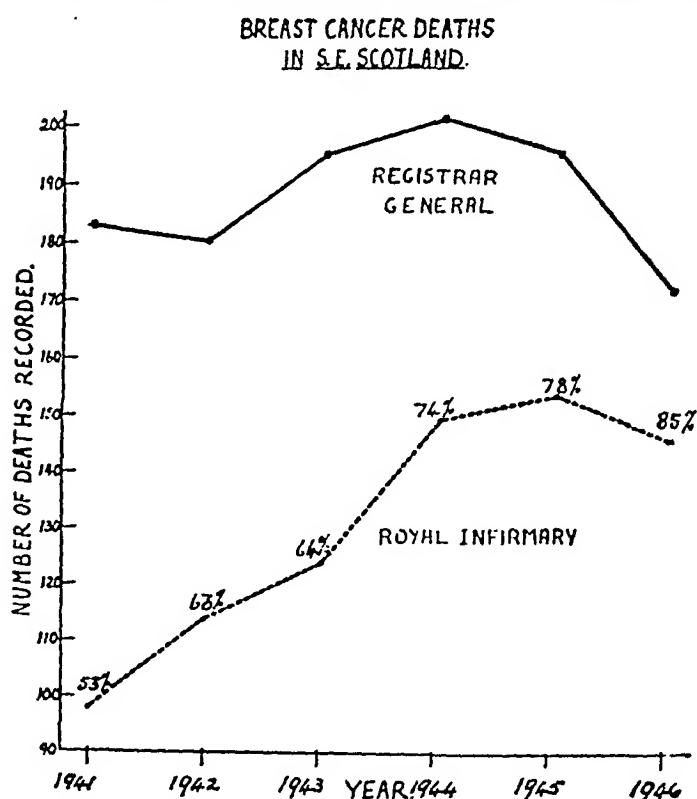


FIG. 1. The number of deaths from cancer of the breast occurring in patients referred to the Royal Infirmary from the southeast of Scotland has been expressed as a percentage of the deaths recorded by the Registrar-General from the same area.

ascertain the incidence of breast cancer in southeast Scotland, and in order to do so the general practitioners in the area have been especially requested to refer all cases to the Royal Infirmary no matter how advanced they are. That most cases are now being referred is indicated in Figure 1.

The significant feature in Figure 1 is the fact that nearly all deaths now being recorded by the Registrar-General are occurring in patients already referred to the

5. If there are no palpable axillary glands no dissection should be performed, but superficial mobile glands in the subpectoral region and outside the axillary fascia may be removed. Any further dissection of the axilla will defeat the whole purpose of the treatment method advocated.

6. If the patient is very stout it is better to carry out a radical mastectomy because in stout patients it is difficult to deliver an adequate dose of roentgen radiation to the axilla.

7. Supraclavicular glands should never be removed because these glands are easily and effectively dealt with by radiotherapy.

by two opposed fields and the anterior field extends up to include the supraclavicular region. The chest wall must be treated by tangential or glancing fields so as to avoid lung fibrosis. The arrangement of the fields is shown in Figure 2.

4. Adequate dosage must be given and in Edinburgh the patients receive a minimal tumor dose of 3,750 roentgens in a period of three weeks. This is the same dosage as is given when clinically obvious local recurrences are treated and it is important not to give less.

5. The roentgen-ray apparatus must be sufficiently powerful to deliver an adequate

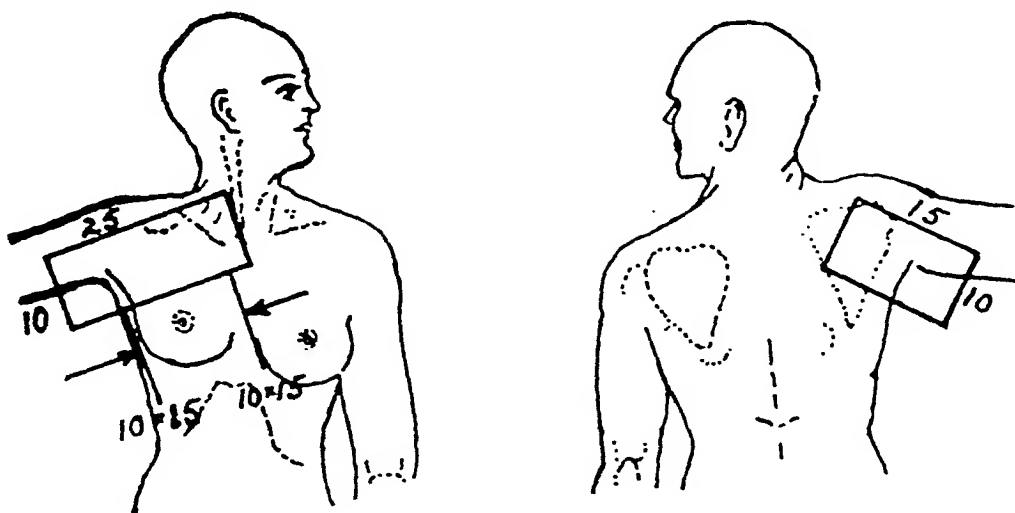


FIG. 2

8. Adhesive should not be applied to the skin after the operation because this lowers the tolerance of the skin to irradiation.

The following points are of importance in postoperative treatment by radiotherapy:

1. Only one full course of roentgen treatment should be given. The practice of repeated courses at intervals of three to six months has no place in the treatment of any form of malignant disease where cure is to be attempted and is just as illogical as partial removal of a tumor at intervals of three to six months.

2. Roentgen treatment should be commenced as soon as possible after the operation; the usual interval is two weeks.

3. Four fields are used and every field is treated every day. The axilla is irradiated

depth dose in the axilla, and it is doubtful if effective radiotherapy can be given with an apparatus of lower voltage than 250 kv. Heavy filtration is employed and the half-value layer of the beam is 3.7 mm. of copper.

SUMMARY

An account has been presented of the method of treatment at present in use in Edinburgh. It must be accepted as representing but one direction in which the survival rates of breast cancer may be improved. There may be other better methods.

Considerable emphasis has been placed on the importance of assessing the true value of a method of treatment so that

better methods may be recognized without undue delay. The view has been expressed that the publication of results of selected cases has greatly confused the issue and has tended to convey the impression that radical mastectomy is a highly successful method of treatment of breast cancer.

When radical mastectomy is the only method of treatment available and when all cases coming to a large general hospital are taken into account, the five year survival rate is unlikely to exceed 25 per cent.

A brief account of the method of treatment by simple mastectomy and radiotherapy has been presented. The five year survival rate of all cases coming to the Royal Infirmary in the period 1941-1942 is 41 per cent.

The most important feature of this method is the substitution of radiotherapy for surgery in the treatment of the axilla. The decision to do so was taken because

when the axilla is not involved by malignant cells it appears unnecessary to carry out an axillary dissection and when the axilla is involved the results of surgical dissection are poor.

A high standard of radiotherapy is essential and adequate dosage must be given. It is most important to appreciate that simple mastectomy and a low standard of radiotherapy will be associated with results poorer than those obtained by radical mastectomy without any radiotherapy.*

I would like to express my thanks to my surgical colleagues in Edinburgh without whose support it would have been quite impossible to have carried out the investigation.

Figure 1 has been reproduced by kind permission of the Editor of the *Proceedings of the Royal Society of Medicine*.

Royal Infirmary
Edinburgh, Scotland

* For discussion see page 349.



TREATMENT AND RESULTS IN CANCER OF THE BREAST

By GRANTLEY WALDER TAYLOR, M.D.

*Visiting Surgeon, Massachusetts General Hospital and Pondville State Cancer Hospital; Assistant
Clinical Professor of Surgery, Harvard Medical School*

BOSTON, MASSACHUSETTS

FOLLOW-UP studies have been carried out on cases of cancer of the breast at the Massachusetts General Hospital for half a century, with special reference to the operable group of cases submitted to radical surgery. During this time, operability has shown no significant change, while the results of operation have improved progressively.

CURES

In computing cures, all cases submitted to operation are included, except the cases who died of intercurrent disease within the five year period without evidence of recurrent disease; these are omitted as inconclusive. Untraced cases, and patients living with recurrent disease, are recorded as failures. Thus the "cured" cases are those known to be living and free from evident recurrent disease five or more years after operation, plus those dying after five years without evident recurrence.

OPERABILITY

There is considerable selection exercised by the public and the physicians of the community in the types of cases referred to a general hospital for operation. In recent years, with the establishment of hospitals for terminal care, or for palliative radiation therapy, numerous cases in the later stages are referred directly to these institutions. This practice has the tendency to increase the proportion of operable cases referred to the general hospital. Offsetting this tendency, there has been an increasing discrimination in selection of cases suitable for operation, which has tended to lower the operability rate. In general, the criteria of

operability have been followed which were recently formulated by Haagensen and Stout.⁹ We drew attention to the unfavorable prognostic significance of many of these factors several years ago.¹⁰ Occasionally, surgical intervention is offered as a palliative procedure in some of the cases not suitable for attempted cure, and these cases have been included in our end-result studies. Thus, in the 1933-1935 series of cases,⁸ there were 20 cases in which on the

TABLE I
CANCER OF THE BREAST
Massachusetts General Hospital

Period	Operability Per Cent	"Cures" Per Cent
1894-1904	77	19
1911-1914	72	27
1918-1920	74	30
1921-1923	80	35
1924-1926	74	41
1927-1929	80	43
1930-1932	80	45
1933-1935	71	50
1936-1940	62*	52

* This figure is based upon the total number of breast admissions during this period, including a large number of secondary and recurrent cases.

basis of the description in the records the disease had advanced to a stage at which operation with a hope of cure was ill advised. We are not convinced that the progress of the disease is accelerated by these palliative operations; and in many instances the care and comfort of the patient is furthered by them. The operations were performed by a large number of surgeons of the visiting and resident staff, and there is

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

some variability in applying the criteria of operability to the individual case. In the series of 395 cases operated upon between 1936 and 1940, there were 3 (0.8 per cent) postoperative deaths.

less radical than those currently employed, and it seems probable that the progressive improvement in results is due to improved surgery as well as to better selection of cases.

RADICAL OPERATION

In general, the operation employed has been a standard radical operation, with removal of the entire breast, both pectoral muscles, and the axillary contents exclusive

FACTORS AFFECTING RESULTS OF OPERATION

Axillary Metastasis. The presence or absence of axillary lymph node involvement is the most significant factor in determining the prognosis after operation. At present, it may be said that when the disease is limited to the breast, the chance of cure is about 75 per cent, while when there is axillary involvement, the chance of cure is about 33 per cent. The improvement over the years has taken place in both groups of cases, as shown in Table II.

It should be noted that the pathologists must make a thorough search of the axillary contents and prepare numerous sections of nodes. It is probable that many of the failures among the "axilla free" group already harbor small metastatic foci which might be discovered by more assiduous search. We have also been able to confirm the findings of Warren and Tompkins¹² that the numerical extent of axillary node involvement has considerable significance in prognosis. Thus we found⁸ that when only one or two nodes presented metastases, the prognosis was nearly as favorable as in the group without metastases, while the results deteriorated progressively with more extensive involvement. The ratio between cases without axillary node disease to the entire group of operable cases varies some-

TABLE II

CURES IN RELATION TO AXILLARY INVOLVEMENT

Period	Axilla Free Cures Per Cent	Axilla Involved Cures Per Cent
1911-1914	56	24
1918-1920	54	23
1921-1923	62	21
1924-1926	64	26
1927-1929	74	24
1930-1932	70	31
1933-1935	75	33
1936-1940	78	34

of the great vessels and nerves. Skin removal is less extensive than that practiced in some clinics, and skin grafting is necessary in less than 10 per cent of the cases. The long thoracic nerve is commonly preserved, and frequently the thoracodorsal nerve and the subscapular vessels. The operation is essentially that described by Halsted and Rodman, and modified by Greenough as described elsewhere.¹¹ Many of the operations in the earlier series were

TABLE III

GRADE AND PROGNOSIS, 1936-1940 SERIES

	Axilla Free Per Cent	Cures Per Cent	Axillary Involvement Per Cent	Cures Per Cent	Local Recurrence Per Cent
Grade 1	100	100	0	0	0
Grade 2	52	80	48	47	7
Grade 3	30	72	70	26	13

what, but in general ranges from 30 to 40 per cent. It was 41 per cent in the 1936-1940 series.

Grade of Malignancy. Several years ago Greenough¹³ applied to mammary cancer the method of grading malignancy developed by Broders for squamous carcinomas. We have found the grade of malignancy to be of very great significance in the prognosis of breast tumors. There is a correlation between the grade of malignancy and the presence of axillary metastasis. Even when cases of comparable extent are considered, it is evident that the high grade malignancy cases present a poorer prognosis.

shown that small tumors have a much more favorable prognosis than large tumors.^{8,10} *Skin involvement and ulceration* present a poor prognosis as noted among the contraindications to operation.^{9,10}

RADIATION THERAPY

Radiation therapy has been used in the treatment of inoperable and of recurrent lesions, and in occasional small groups of cases as preoperative or postoperative prophylactic therapy. The details of radiation dosage and technique have varied over the years. At present prophylactic postoperative irradiation is employed only in cases in which the surgeon believes that he

TABLE IV
SUMMARY—CANCER OF THE BREAST
Massachusetts General Hospital

Years	1894 to 1904	1911 to 1914	1918 to 1920	1921 to 1923	1924 to 1926	1927 to 1929	1930 to 1932	1933 to 1935	1936 to 1940
Total primary cases	468	103	134	183	208	220	231	328	
Radical operations	360	74	100	148	158	180	185	236	395
Operability per cent	77	72	75	80	74	80	80	72	
Died without recurrence in less than 5 years				6	11	10	11	14	11
Axilla free per cent	33	31	30	28	41	36	37	40	41
Cures per cent I A cases		56	54	62	64	74	70	75	78
Cures per cent I C cases		24	23	21	26	24	31	33	34
Cures per cent All Ops.	19	27	30	35	41	43	45	50	52

Other Factors. There are numerous other characteristics which appear to have a distinct bearing on the prognosis following operation. In a previous study¹⁴ it was shown that the *age* of the patient was significant chiefly in that young women have a greater proportion of carcinomas of high grade of malignancy, and that axillary lymph node involvement may occur earlier in the course of the disease. The *duration* of the primary tumor is of great significance in the individual case; in that the earlier the operation is performed, the less likelihood there is of metastasis having occurred. The *size* of the primary tumor is related to its duration, grade of malignancy, and perhaps the age of the patient; and we have

has left gross disease. We have been unable to establish that prophylactic irradiation has improved the results of operation, or has decreased or deferred the appearance of operative field recurrences.

HORMONE THERAPY

In recent years significant aids in the treatment of breast cancer have developed in the revived employment of castration, and in the use of estrogenic and androgenic hormones. Castration may be effected by means of irradiation or by operation. At present, we employ surgical in preference to irradiation castration, on the ground that the results are more dependable and more promptly achieved. In a series of cases

treated several years ago by prophylactic irradiation castration following radical mastectomy,¹⁵ we found no increased curability in this group as compared with a control series. Accordingly, we now do not employ castration prophylactically, but only in the treatment of inoperable and recurrent cases in young women. The most striking favorable results are observed in patients with skeletal metastases. Estrogenic hormones are employed in the treatment of inoperable and recurrent carcinoma, especially in elderly patients in whom benefit is shown chiefly in regressions of local and lymph node disease, and of pulmonary metastases. Androgenic hormones appear to be beneficial primarily in patients with skeletal metastases. These adjuvants are too recent to warrant conclusions as to their place in the treatment of mammary carcinoma; and at present their employment is experimental.

CONCLUSION

In our opinion, the treatment of operable cancer of the breast is by radical surgery, which may be expected to effect a five year "cure" in about 50 per cent of patients submitted to operation. When there is no axillary involvement, about 75 per cent are cured, while when there is axillary involvement the cures are about 33 per cent. Narrowing of the criteria of operability will result in lower operability and at the same time increase the percentage of cures among the cases submitted to operation. In our experience, the employment of prophylactic irradiation, preoperatively or postoperatively, does not increase the number of cures nor defer recurrences.*

264 Beacon St.
Boston 16, Mass.

REFERENCES

1. GREENOUGH, R. B., SIMMONS, C. C., and BARNEY, J. D. Results of operations for cancer of breast at Massachusetts General Hospital from 1894 to 1904. *Surg., Gynec. & Obst.*, 1907, 5, 39-50.
2. GREENOUGH, R. B., and SIMMONS, C. C. End results in cancer cases; cancer of breast. *Boston M. & S. J.*, 1921, 185, 253-260.
3. GREENOUGH, R. B. Carcinoma of breast; results of treatment, 1918, 1919, 1920. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 16, 439-443.
4. GREENOUGH, R. B., and TAYLOR, G. W. Cancer of breast; end-results, Massachusetts General Hospital, 1921, 1922, and 1923. *New England J. Med.*, 1934, 210, 831-835.
5. SIMMONS, C. C., TAYLOR, G. W., and WALLACE, R. H. Cancer of breast; end-results, Massachusetts General Hospital, 1924, 1925, and 1926. *New England J. Med.*, 1934, 210, 836-844.
6. SIMMONS, C. C., TAYLOR, G. W., and ADAMS, H. D. Cancer of breast; end-results, Massachusetts General Hospital, 1927, 1928, and 1929. *New England J. Med.*, 1936, 215, 521-525.
7. SIMMONS, C. C., TAYLOR, G. W., and WELCH, C. E. Carcinoma of breast; end-results. Massachusetts General Hospital, 1930, 1931, and 1932. *Surg., Gynec. & Obst.*, 1939, 69, 171-177.
8. TAYLOR, G. W., and WALLACE, R. H. Carcinoma of breast; end-results, Massachusetts General Hospital, 1933, 1934, and 1935. *New England J. Med.*, 1947, 237, 475-477.
9. HAAGENSEN, C. D., and STOUT, A. P. Carcinoma of breast; criteria of operability. *Ann. Surg.*, 1943, 118, 1032-1051.
10. TAYLOR, G. W., and BRUCE, N. H. Prognostic factors in carcinoma of breast. *New England J. Med.*, 1940, 222, 790-792.
11. TAYLOR, G. W., and DALAND, E. M. Greenough technique of radical mastectomy. *Surg., Gynec. & Obst.*, 1937, 65, 807.
12. WARREN, S., and TOMPKINS, V. Significance of extent of axillary metastases in carcinoma of the female breast. *Surg., Gynec. & Obst.*, 1943, 76, 327.
13. GREENOUGH, R. B. Varying degrees of malignancy in cancer of breast. *J. Cancer Research*, 1924-1925, 9, 454-463.
14. TAYLOR, G. W. Carcinoma of breast in young women. *New England J. Med.*, 1936, 215, 1276.
15. TAYLOR, G. W. The value of artificial menopause in cancer of breast. *New England J. Med.*, 1935, 213, 1202-1203.

* For discussion see page 349.



CANCER OF THE BREAST*

By DR. BRIAN W. WINDEYER

Professor of Radiotherapy, University of London; Director of Meyerstein Institute of Radiotherapy, Middlesex Hospital, London

LONDON, ENGLAND

THE material on which my contribution to this discussion is based consists of 1,091 patients suffering from cancer of the breast who sought advice and treatment at the Middlesex Hospital during the years 1936-1942. These years have been chosen because they follow the period 1926-1935 which was the basis of the recent survey by B. M. Truscott of cases of cancer of the breast treated at this hospital, and they include all cases up to 1942 which is the last year on which full five year statistics can be based. In 1936 also the roentgen therapy and radium departments were merged into the present radiotherapy department and there was a radical alteration in the technique of roentgen therapy in the treatment of cancer of the breast.

The total number of 1,091 patients who applied for treatment is made up of the following groups:

(a) 977 patients who had had no previous treatment.

(b) 114 patients who had been submitted to operation at other hospitals by a variety of surgeons with some variation in the type of operation performed and who had been referred for postoperative roentgen therapy.

Of the first group of 977 patients, 60 received no treatment—44 because they were considered to be too advanced and 16 because they refused the treatment offered—917 were treated by surgery, or radiotherapy, or by a combination of these methods.

This group of 917 cases was divided into stages according to the clinical classification adopted at Manchester which is as follows:

Stage I. The growth is confined to the breast. Involvement of the skin directly

over and in continuity with the tumor does not affect staging provided that the area involved is small in relation to the size of the breast.

Stage II. As Stage I but there are palpable mobile lymph nodes in the axilla.

Stage III. The growth is extending beyond the corpus mammae as shown by:

(a) The skin is invaded or fixed over an area large in relation to the size of the breast.

(b) The tumor is fixed to underlying muscle. Axillary glands may or may not be palpable but if glands are present they must be mobile.

Stage IV. The growth has spread beyond the breast area as shown by:

(a) Fixation of axillary nodes indicating extension outside the capsule.

(b) The tumor is completely fixed to the chest wall.

(c) Secondary lymph nodes in supraclavicular region.

(d) Secondary deposits in skin wide of tumor.

(e) Secondary deposits in the opposite breast.

(f) Distant metastases, e.g. bone, liver, lung, etc. The results of treatment have been summarized in Table 1.

The methods of treatment which have produced these results have shown considerable variation throughout the series as they have been adapted to the treatment of individual cases in different stages of the disease, and because the series of cases is a composite one, representing the work of a number of surgeons and of the radiotherapy department. In general radical mastectomy was used in Stage I cases, radical mastectomy with postoperative roentgen therapy was used in Stage II and the majority of

* Presented in a Panel Discussion on Treatment and Results in Cancer of the Breast at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20-22, 1948.

Stage III cases; roentgen or radium therapy alone or in some cases associated with conservative surgical excision was used in the remainder of Stage III and in Stage IV cases.

The most obvious fact which appears from Table I is that in comparison with other published work the results in Stage I show a relatively low five year survival and the results in Stages II and III show a relatively high five year survival. This is obviously accounted for by the fact that the classification adopted is a clinical one which seemed most appropriate for this composite series. It is generally recognized

nation and the results in terms of five year survival will be better than when Stage II is based entirely on a histopathological classification.

The results have been described in terms of five year survival as it has been impossible, in restarting our follow up department after the war, to ensure the attendance of every patient for examination to determine their freedom from disease and some information had to be obtained by correspondence. The follow up has been successful to the extent that only 24 of the 917 patients remain untraced, i.e., 2.6 per cent. For the

TABLE I
CANCER OF THE BREAST

	1936-1942		1936-1937	
	Cases treated	5 year survivals	Cases treated	10 year survivals
Stage I	255	160 = 62.7%	71	30 = 42%
Stage II	193	67 = 34.7%	51	16 = 31%
Stage III	235	66 = 28%	84	14 = 16.6%
Stage IV	234	19 = 8%	76	2 = 2.6%
	917	312 = 34%	282	62 = 21.9%

		5 year survivals	10 year survivals
1925-1935 (Truscott)	Treated cases	24.8%	10.9%
1936-1942	Treated cases	34%	21.9%

Haagensen and Stout	Absolute 5 year survival	25.3%	All cases referred
Middlesex Hospital 1936-1942		31.9%	All cases primary cancer referred
McWhirter 1935-1940		32.4%	All cases referred

that a clinical classification of Stage I will include an appreciable percentage of cases with glands found on histopathological examination to be involved with cancer, and that the percentage of five year survivals will be lower than when Stage I is based entirely on a histopathological classification. Similarly a clinical classification of Stage II will inevitably include some cases in which the enlarged glands are found to be uninvolved on histopathological exami-

years 1936-1937 on which the ten year figures are based the untraced are 2 of the 282 patients, i.e., 0.7 per cent. No deductions have been made for the untraced patients and the results are a crude survival rate of all patients treated.

A comparison of the results of radical mastectomy alone, with those of radical mastectomy in combination with radiotherapy in various stages was considered, but it was obvious that any such compari-

son in this series could not be of value as the groups of cases were not unselected. With some exceptions it was the general rule that cases which appeared to have a worse prognosis at or after operation would be referred for postoperative radiotherapy, and a true comparison of the relative merits of the two methods of treatment could not be obtained. For such a comparison to be of value in a series such as this it would be necessary to plan beforehand and to treat groups by both methods in which the selection was a purely random one.

This series of cases may, however, be of some value for comparison with the over-all results of treatment of the survey made by Truscott of the cases treated in the previous ten years and also for comparison with other published results. It is particularly of value for comparison with Truscott's series as they both represent the total number of cases coming to the same hospital and there is unlikely to be a great difference in the quality of the material, although the present series is from the following decade.

Truscott found that an analysis of 836 treated cases of primary cancer of the breast gave 24.8 per cent of five year survivals and 10.9 per cent of ten year survivals. The figures of this series show 34 per cent of five year survivals of treated cases and 21.9 per cent of ten year survivals of treated cases, an increase of 10 per cent at both five and ten years.

Haagensen and Stout found an absolute five year survival of 25.3 per cent from a total of 1,040 cases referred to the hospital. In the present series there are 312 five year survivals from a total of 977 cases of primary breast cancer referred to the hospital, i.e., a survival rate of 31.9 per cent. The ten year survival rate from 300 cases of primary breast carcinoma referred to the hospital is 62, i.e., 20.6 per cent. The absolute five year survival rate in the present series is 365 from a total of 1,091 which is 33.4 per cent but this is not truly comparable with Haagensen and Stout's figure as it is improved by the inclusion of 114 cases referred for postoperative radiotherapy after

operation elsewhere. Of these there were 49 five year survivals, or 42.9 per cent.

The figures for five year survivals in the present series are very similar to those quoted by McWhirter for the period 1935-1940 when the main method of treatment at Edinburgh was radical surgery and postoperative radiotherapy. In his cases there were 32.4 per cent of five year survivals from a total of 790 patients treated.

The most obvious change in treatment which may account for the marked improvement in results compared with those described by Truscott was the alteration in radiotherapy technique which took place in 1936. From that time postoperative radiotherapy has been given as an intensive course of roentgen therapy, using 220 kilovolts, with a half-value layer of 2.1 mm. of copper. The whole of the chest wall on the operated side has been treated by two opposing tangential fields, irradiating from the opposite side of the sternum to the posterior axillary line. The axilla, retroclavicular and supraclavicular regions have been treated by two opposing and posterior fields. The total dose given has been routinely 2,500 to 3,500 roentgens, delivered over a period of thirty to thirty-five days. This treatment came to be used more extensively following radical mastectomy in the cases with axillary metastatic involvement. There was also a tendency to restrict surgical intervention in the more advanced cases and to rely on radiotherapy in the form of roentgen treatment or radium implantation, or a combination of both.

The cases described by Haagensen and Stout were a similar unselected series to those forming the material for this paper as they represented the total cases seen at a large general hospital. The main method of treatment used was radical mastectomy although preoperative and postoperative irradiation had been used in some cases. The authors have concluded that there is no evidence that the additional radiotherapy has had any influence in improving the results of radical mastectomy. In their cases, however, as in the present series, it

was not possible to obtain a true comparison of the results of radical mastectomy alone with those of radical mastectomy and postoperative radiotherapy as the groups were not unselected; and from the evidence produced it seems that this question remained unsolved. It seems, however, that the technique of roentgen therapy employed throughout their series of cases, which were treated prior to 1934, was less intensive than that described in this present series. It may be argued that the improvement in results which has been shown in the cases which I have reported is related to the more intensive roentgen therapy. The similarity of these results from the

tients who had been submitted to operation elsewhere and referred for postoperative roentgen therapy showed that there were 49 five year survivals, i.e., 42.9 per cent. This group also is likely to give a lower five year survival rate than that of all "operable" cases as it is to some extent selected because the earliest cases with no axillary metastases were rarely sent for postoperative roentgen therapy.

The analysis of this series of cases may have contributed something towards producing a yardstick of what can be achieved by radical mastectomy in early cases, radical mastectomy and postoperative roentgen therapy in later operable cases, and radio-

TABLE II
OPERABLE CASES

	1936-1942		1936-1937	
	Cases treated	5 year survivals	Cases treated	10 year survivals
Stage I	255	160	71	30
Stage II	193	67	51	16
Stage III	235	66	84	14
Total operable	683	293 = 42.9%	206	60 = 29%
Operation elsewhere; postoperative roentgen therapy	114	49 = 42.9%		

Middlesex Hospital with those from Edinburgh during the period 1935-1940, when radical mastectomy and postoperative radiotherapy with very similar technique was the main method employed, tends also to confirm this view.

It may be of value to consider the so-called "operable" groups of cases. With the adoption of the criteria of inoperability of Haagensen and Stout the cases in Stage IV and some of the cases in Stage III in this series will be considered inoperable. A consideration of Stages I, II and III as "operable" will therefore give a high operability rate with a somewhat low five year survival rate (Table II).

Consideration of the group of 114 pa-

therapy in advanced cases. These are the results of treatment up to the last year on which five year results could be produced. Since that time there have been many cases under treatment and there has been some evolution in technique.

I do not now propose that treatment planned on the basis described is the best than can be obtained. The use of preoperative roentgen therapy has some advantages over postoperative treatment. There are many difficulties in delivering an adequate dose of roentgen radiation to the chest wall as a postoperative measure following radical mastectomy. There is little tissue covering the ribs and the blood supply of the area has been seriously disor-

dered. There is the risk of necrosis of skin and also of underlying ribs. From my experience of the irradiation of border line and advanced cases and more recently of operable cases, I am sure that preoperative irradiation can be given with more adequate dosage, with less risk, and without impeding the healing of a subsequent radical operation. It will be necessary to wait some time to see the results of our cases in terms of five year survivals, but I am convinced that there is sufficient evidence available to advocate, (1) for *all* inoperable cases radiotherapy alone with possible subsequent local removal or excision; (2) for *all* operable cases preoperative roentgen therapy followed by radical mastectomy. There are obviously many early cases with no axillary metastases and in these I do not think that associated roentgen therapy is likely to improve the survival figures. It is, however, impossible on clinical examination to eliminate patients with histopathological involvement of glands which are not clinically palpable. Therefore in order to obtain the maximum survival figure the routine use of preoperative roentgen therapy in *all* operable cases would seem to be a rational procedure.

Meyerstein Institute of Radiotherapy
Middlesex Hospital
London, England

DISCUSSION OF PANEL DISCUSSION ON TREATMENT AND RESULTS IN CANCER OF THE BREAST*

DR. MAURICE LENZ (Moderator of the Panel Discussion), New York. This most interesting panel discussion on "The Treatment and Results in Cancer of the Breast" illustrates the divergent views which the discussants held on the relative merits of radical versus simple mastectomy, and mastectomy with and without preoperative and postoperative roentgen therapy. Of all the speakers only Professor McWhirter has championed simple mastectomy and treatment of the axilla solely by roentgen radiation. He used a tumor dose of 3,750 roentgens in three weeks. It may be questioned

whether this dosage suffices to destroy every cancer cell in the axilla, or whether radical mastectomy, including axillary dissection, should remain the treatment of choice. He is probably right, however, in his preference for two instead of multiple opposing fields and in the use of scattering material to make the distribution of the radiation in the depth more homogeneous. He may also be correct in that part of the tangential beam directed at the breast laterally and mesially may be absorbed by the ribs. In our arrangement of the fields crossfiring the tumor, however, this loss, we believe, is insignificant.

Our hesitance to accept 3,750 r in three weeks as adequate to destroy mammary cancer is based on information obtained from a study of three series of patients who received roentgen therapy for cancer of the breast at the Presbyterian Hospital, New York, from 1923 to 1940. The first was a series of 78 patients receiving tumor doses of 300 to 2,300 r in a few weeks after mastectomy. Five year survival in this group of patients was about the same as in patients who were not irradiated after radical mastectomy, and skin recurrences in 8 of 9 instances developed in the irradiated area. The second series consisted of 38 patients who were given tumor doses of 4,500 r in two months, and had radical mastectomy a few days to one year after the roentgen therapy. The tumor dose was calculated at the center of the palpable tumor, in the breast and axilla. Many tumors disappeared grossly, and on microscopic examination there were noted marked retrogressive radiation changes in the cancer cells. In all of the specimens, however, some recognizable cancer cells were still present and complete destruction of the cancer could not be claimed in a single instance. The third series consisted of 32 non-operated patients receiving tumor doses of 6,000 to 8,000 r in three to three and a half months. Of the 32 patients, 10 with disease limited to the breast and axilla are now free from clinical evidence of mammary cancer eight to ten years after treatment. Viable cancer cells may still lie dormant in the depth of the irradiated breast and axilla, but clinically there is no evidence of growth. There were not any five year survivors among patients with skin metastases en cuirasse or other evidence of extension beyond the breast and axilla, or when the tumor dose was less than 5,500 r. Baclesse reported clinical disappearance "in a significant proportion, only after a dose of about 5,000 r." Our own experience just quoted suggests that long

* Papers by Drs. Baclesse, Berven, Cade, Haagensen, McWhirter, Taylor, and Windeyer.

term clinical arrest of cancer of the breast is more likely after higher dosage. Therefore, we do not believe that the much weaker dosage used in routine postoperative roentgen therapy ever destroys mammary cancer completely. We reserve this weaker treatment for cases in which the surgeon, or preferably the microscopist, believes that the cancer has not been completely removed and give it in the hope of producing temporary growth restraint. The addition of preoperative and postoperative roentgen therapy in cases of borderline operability seems less efficient than stricter separation of cases into those suitable for radical mastectomy and those which should not be operated on. The former need not be irradiated and the latter should be treated only by radiotherapy. We prefer to follow this policy although we respect Berven's leaning toward preoperative roentgen therapy as well as Cade's and Windeyer's reliance on postoperative treatment. Taylor of the Massachusetts General Hospital and Haagen-sen of the Presbyterian Hospital have shown that strict selection of cases for mastectomy and increased operative experience result in improvement of surgical statistics. If selection of patients with mammary cancer for operative treatment would be more severe, there would be less need for preoperative and postoperative roentgen therapy.

DR. FRANK E. ADAIR, New York. This is a remarkable symposium. The results of therapy of breast cancer are presented from five countries and seven different clinics. The interesting fact in comparing these papers is not their great differences but in the striking similarity of therapeutic results. These can be best brought out by Table 1 which I have built from the submitted abstracts of the authors. Unquestionably, the cancer material differs as well as the irradiation and surgical skills in different clinics. But probably the greatest cause of differences in results is the varying methods of handling the *statistics*, which does differ greatly in each clinic. There is a crying need for uniformity in this field. Until all use the same *statistical* technique, results will be only mildly comparable.

There is a tendency on the part of some authors to a high degree of selectivity of material. This is not proper procedure unless the total material is reported. One must give not only the report on the material operated on, but it is equally important for us to know what happened to the material which was turned down;

and was not operated on. One of the most common and inexcusable faults in the study of cancer cases is the selection of only good cases on which to operate. As Taylor brought out, Grade 1 breast cancer is capable of cure in 100 per cent. If one were interested only in a high cure rate, obviously he would select Grade 1 material. The same holds for other cases such as cases of pregnancy with breast cancer. I think it is wrong to classify such cases as inoperable and deny them their chance of cure even though it is not favorable material. However, in the light of Barney Brooks' study on his cases of pregnancy, in which he obtained 38 per cent survival at the end of five years, and of my own material in which 25 per cent were alive at the end of five years, I feel that it is improper to classify the *breast cancer-pregnancy* cases as inoperable. Similarly, many other manifestations of breast cancer which are unfavorable (but not constituting inoperability) should not be excluded just in order to attain a high cure rate in a small, highly selected group. As yet, radiation therapy and hormones are not to be relied on for cure of breast cancer. A glance at Table 1 shows those operable cases treated by irradiation alone in the hands of Baclesse and Adair gave only 21 and 25 per cent respectively. With such accomplishments, one should consider seriously our personal responsibility before denying a patient a radical operation, when the next best agent we have at present possesses only half as many cures.

Berven reports a very low rate (3 per cent) of local recurrence. Cade reports the highest cure rate of all, namely 87 per cent in those cases of disease confined to the breast. They were treated by surgery alone. His studies are especially interesting as they give the comparative figures of cases treated by radium alone, and surgery plus radium. Haagensen's local recurrence rate is interesting (11.4 per cent) as he constantly emphasizes the routine skin graft in his writings. Today, with patients coming so much earlier for therapy, before the tumors become bulky, I do not think a routine skin graft necessary. It should be here brought out that a helpful addition to breast surgery is the greater use of loosening up the skin over the sternum and making greater employment of the opposite breast for repair of the plastic defect. McWhirter has presented a stimulating and controversial paper. His clinic is unique in that practically all the breast cancer material in that portion of Scotland filters into his radiation clinic.

TABLE I
"OPERABLE" BREAST CANCER

	Ba- clette	Berven	Cade	Haagensen	McWhirter	Taylor	Win- deyer	ADAIR
Five year cures; Stages I and II combined				48% Presby- terian Hospital; 59% Personal series	Radical +roentgen irradiation =39.5%; Simple +roentgen irradiation =48.7%	50%		59.2%
(Stage I) Breast alone involved		60 to 61%	Radium=70% Surg+Ra=78% Surgery=87%	71%	Radical 80%	75%	62.7%	83.2%
(Stage II) Breast and axilla in- volved		30 to 34%	Radium=25% Surg+Ra=35% Surgery=29%	37%	Radical 45.4%	33%	34.7%	44.3%
Per cent having axillary involve- ment		62.3%		62%		60%		62%
Local recurrence		3%		11.4%		7 to 10%		10%
Operative mor- tality			1.65%	1.8%		2%		0.29% (1 in 325)
Five year cures by irradiation alone	21%							25%

To me, his paper would indicate that the best way *not* to treat operable breast cancer is by a simple mastectomy with subsequent radiation therapy. His radical mastectomy material gives 80 per cent survival in those cases having disease confined to the breast; which is extremely gratifying. Curiously, in his over-all cure rate of operable material, the radical plus roentgen treatment gave 39.5 per cent; while the simple mastectomy plus roentgen therapy gave 48.7 per cent. This is contrary to our experience at Memorial Hospital, where we have been disappointed in the results of irradiation in axillary disease, due to the great spottiness and irregularity of results accomplished by irradiation there.

Taylor's results represent a high standard of competency. His definite statement that post-operative irradiation produces more cases of lymphedema of the arm is arresting. It signifies that we must balance the good accomplished by irradiation against the evil which it produces

by adding to the number of lymphedema cases.

Professor Windeyer's contribution as usual is sound and brought out many valuable points.

The Radium Society is to be congratulated on the high quality of this Symposium.

DR. BERVEN (closing). Dr. Adair's table needs correction as our table pertains to cure rate and not survival. For Stage II it is 24 per cent for the period 1921 to 1935, and 40 per cent for the later period.

Someone asked "Since five year results may vary as much as 20 per cent or more from one to another of two hospitals in your own city, would it not be better to judge the usefulness of adjunct radiotherapy on the basis of its ability or inability to reduce local recurrence below a minimum?" Only one of the two hospitals is in our city. The other material comes from county hospitals all over Sweden. Our local recurrences are very low. They are only 3 per cent.

If you use the same method of treatment in a

different material you get different results. In Karolinska Hospital we have all patients, early cases in Stage I, more advanced cases in Stage I, all cases in Stage II, and we see the difference in results; 80 per cent in Stage I and 45 per cent in Stage II. The material coming from the county hospitals is different. The surgeons in the county hospitals do not send the very early cases in Stage I or II to the Radiumhemmet but send the bad inoperable cases with periglandular extension which they have tried to operate on. This accounts for the fact that in spite of the same method of treatment, the results are different, depending upon the clinic from which they came.

SIR STANFORD CADE (closing). I should like to answer a question about the method of irradiation which I believe was asked by the Chairman. Up to the period of 1938, and that is why I put radium and surgery in my tables, irradiation of breast cancer was carried out by radium; that is, interstitial radium needles plus a surface applicator. By this method we can raise the tissue dosage to very high figures, 9,000 r. In a small group of cases, perhaps 20 or 30, but no more, telerradium alone was used. Since 1938 we have reversed our irradiation of the breast to comprise what we find is a more flexible and an equally effective method.

DR. HAAGENSEN (closing). I did make a plea for absolute cure rates and I presented such figures.* They were 38.7. The absolute survival rate, if we might distinguish here between survival and cure, was 47.3. These are absolute cure rates and survival rates, and if all of us had these figures from all the larger cities of the world, we would perhaps be able to show that in clinics where there is a greater tendency toward radical surgery, the results are worse perhaps or better than in those clinics where there is a greater tendency toward the use of radiation. This would be a crude sort of differentiation which we might use to advantage.

Someone asked how many patients who do not have involved lymph nodes clinically, that is Stage I, actually have them microscopically. In our experience 45 per cent of the patients in whom no lymph nodes were palpable proved to have axillary metastasis. This is a very great and to us an inseparable objection to the matter of basing your plan of treatment on whether

or not the patient on clinical grounds has axillary nodes. We feel that we must give every patient the treatment which we think is best for patients that have axillary involvement and that means the most radical surgical attack.

I am sure that at least six months' time would be lost in the surgical attack if we gave adequate preoperative roentgen therapy, say, a tumor dose of 5,000 or 6,000 r, and there would also be real surgical hazards involved in doing the kind of radical mastectomy we try to do after that much radiation. Either we rely on surgery, the best kind of surgery we can do, or we do not use surgery and rely on irradiation.

Surgery has not yet exhausted all its possibilities. We can still attack the mediastinum, which is the second most important route by which the disease extends. This is a logical surgical attack and we have begun to do it in a small way.

DR. McWHIRTER (closing). Let me repeat right at the beginning that this investigation which has been done in Edinburgh is still in an incomplete stage. I agree completely that the information will be much more reliable after ten years. It will become, indeed, very reliable if the Registrar General does not let us down.

I was impressed by the slides shown by Dr. Baclesse in cases treated by radiotherapy alone, and I was impressed, too, with the cases shown by Dr. Lenz treated by radiotherapy alone after a period of ten years. I, too, have cases treated by radiotherapy alone after ten years, because while one intends to treat the majority of the patients by simple mastectomy and radiotherapy, obviously in many of the advanced cases it is not possible to do any operation at all, nor is it advisable.

In the cases such as Sir Stanford Cade showed with gross involvement of the breast, even simple mastectomy would be an entirely wrong procedure. These cases we treat by roentgen irradiation alone.

"If survival rates are based on vital statistics are they not subject to errors of clinical judgment unless all causes of death are established by postmortem examination?" was asked me, and also "What is your proportion of local recurrences?"

As to this statistical difficulty, which we are so constantly up against and which led me to make the plea that at the next International Congress we consider very seriously a common language of figures, Professor Berven showed

* Dr. Haagensen made slight changes in some of the figures given in his paper when proof was sent to him.—Ed.

the difference in two hospitals and he has explained that, but if he worked at one hospital and someone else worked at the other the results would be different, different because the material is basically different. That I think is the very important point which comes out there. Perhaps I should put my figure on the blackboard. I take Paterson's classification of Stages I and II as being the truly operable cases. On that basis this is radical surgery plus roentgen irradiation. Histopathologically negative glands at the end of five year survival rate, 80.5 per cent and with glands histopathologically positive, 45.4 per cent.

I cannot give the figures for simple mastectomy, obviously.

I was very impressed with Dr. Haagensen's figures. They are extraordinarily good, but I think there is a difference in the material which we compare. In the personal series, which he indicated, only 2 out of 103 were inoperable. I presented 15 per cent inoperables due to the fact that we collect large numbers of advanced cases from hospitals where patients are admitted often with other conditions or in terminal stages of breast cancer.

Again I return to the question of selection, and in Dr. Taylor's figures the best results were in the most recent years where the selection was highest. Even when the glands were not involved the figure progressively increased over the years. I find difficulty in understanding why that should be unless it has been on the basis of selection. There was also a progressive improvement in the cases where the nodes were histopathologically involved. That is understandable because there has been a general tendency for the operation to become more radical and for the cases to be more carefully selected so far as skin involvement is concerned.

May I just make a further point. In my cases presented there were approximately 40 different surgeons operating. Some of those men are attached to small hospitals. If I take one surgeon's figures who is particularly interested in breast cancer and has tried out a large number of operations, his figures are 10 to 15 per cent higher than I have shown you. A personal series would always be higher than a general hospital figure, and considerably higher if one attempts to take in all the cases in the area served by the hospital.

I should like just to impress, too, that not all the cases were treated by simple mastectomy and radiotherapy, only cases where that ap-

peared to be indicated. In a large number of cases that was impossible.

I apologize for the misunderstanding about propaganda to the public. That has been my policy in southeast Scotland and it does not extend beyond that. Because of the rate of error in diagnosis I do not believe that the medical profession yet has accepted the viewpoint that any lump in the breast is a cancer until proved otherwise.

How do we know that we produce sterilization in the area? Well, we don't, but the patients are alive. They are symptom free. They are useful members of society. They have no complaints. I say this quite deliberately. They may still have cancer cells present. From the discussion I still think the method, so far as it goes, has proved quite sound. It is perhaps better to have a patient alive with a few cells which are not causing any trouble than dead.

The question of the use of vital statistics. I agree that the death certification is quite unreliable in many sites. One could not use this method, for example, in the evaluation of cancer of the stomach. It would be quite unreliable, but I will put this point to you. It must seldom happen that a patient is certified as having died from breast cancer unless in fact she had breast cancer. I think that point comes out clearly, and it may be that a number of patients who had a breast removed and who died from some other causes were certified as having died from breast cancer, but you see that loads against the argument which I presented to you. As to the percentage of local recurrences, I cannot give that figure directly. All I can say is that it is extremely low.

Dr. Lenz posed the question that 4,500 r will not sterilize the breast area. That I think is in two months' time. The dosage which we give, 3,750 r in three weeks, is probably a higher biological dose. There are three other points which I would make there. Dr. Lenz uses multiple fields. I am perhaps wrong but I believe firmly that if one is to obtain reliable statements of dosage there should be two opposed fields only, and that if there are multiple fields one can arrive at erroneous conclusions as to the minimum dose in the tumor area. One may calculate the obvious dose or a dose at a particular point, but the dose should be calculated at every point in the possible area of involvement. There is a tendency, too, and I am not sure whether that operates in Dr. Lenz's cases, to direct a field straight into the axilla. That I

think is wrong because the axillary skin will not tolerate dosages well, and while the skin reaction may be very marked, the rapid falling off in dosage in the axilla will not produce good results.

The question of bolus scattering material in the area again I think is extremely important. I am surprised to find that frequently bolus material is not used. If two opposed fields are used with the breast in situ and no bolus is added, the dosage on the summit of the breast will be almost exactly twice the incident dose given by those two fields because the fields are no longer entering and being scattered by water or wax or tissues. The dosage at the deeper part of the breast will be much lower than that estimated from the isotope curves. If bolus material is added so that full scattering is obtained, the dosage at all points becomes almost identical. It is essential to use bolus, and if that is not done it can cause an erroneous estimation of the actual dosage given.

DR. TAYLOR (closing). We do not use preoperative roentgen therapy and think a tumor dose of 1,500 r, as suggested by Dr. Berven, is inadequate. We do not use postoperative roentgen therapy routinely but have tried preoperative and postoperative treatment in about 50 cases. We have never felt that it influenced our results in any way.

The question was asked whether there was any evidence that roentgen therapy, given for recurrent or inoperable disease, prolongs the life of the patient. The only study I am aware of, on that, was published by Dr. Greenough many years ago, in the first report from the American College of Surgeons when they first began to assemble cases from a large number of clinics. He plotted the survivors following radiation therapy for inoperable disease against the curves which Daland had originally made, of the disease in untreated cases, and found that the graph for survivors following radiation therapy coincided exactly with Daland's curves for untreated cases. He concluded, therefore, that radiation therapy, although it improved the patient's comfort and frequently healed up ulcerations and otherwise was a very markedly beneficial palliative procedure, did not prolong

the patient's life. To the best of my knowledge, there have been no further studies contributing directly to that problem.

The question was asked whether radiation castration can be shown to be beneficial as a prophylactic procedure following radical mastectomy or associated with radical mastectomy in operable cases in women before the menopause. I made a study on that several years ago in which we carried out an artificial menopause on 50 patients following radical mastectomy and compared them with a control series in which we had not carried out the radiation castration, and I was unable to establish that the prophylactic castration was of the slightest benefit in increasing the number of survivors or postponing the incidence of recurrence. That is quite different from the therapeutic use of radiation castration when recurrent disease establishes itself, especially skeletal metastatic disease.

DR. WINDEYER (closing). First, in answer to the questions which are posed to me, we do take biopsies in early cases in which we have doubted the diagnosis. There are obviously many cases, such as those which you have seen depicted here on the slides, in which there can be no reasonable doubt that one is dealing with a cancer and we do not take biopsies in those but we do get histological proof of them. I am not suggesting that our method of preoperative irradiation does sterilize the growth completely in all cases, but as I tried to point out before, I still believe that there is value in doing it even though there are demonstrable cancer cells which are also demonstrably damaged at the time of operation.

Dr. Haagensen poses the question which I think is the crux of this, as far as I am concerned, and that is the question of delay between irradiation and operation. He says it would take six months. We are doing it somewhere between three and four months and so far haven't got into any trouble with it. I do think that this is a very important point, this question of how long afterwards you are going to do any surgical procedure because there is an optimum time. If you delay too long you get into more trouble because you get more fibrosis.



AUTOMATIC ROENTGEN-RAY ROLL-FILM MAGAZINE FOR ANGIOCARDIOGRAPHY AND CEREBRAL ARTERIOGRAPHY*†

By CHARLES T. DOTTER, M.D., ISRAEL STEINBERG, M.D., and
HAROLD L. TEMPLE, M.D.

NEW YORK, NEW YORK

VARIOUS devices for producing multiple roentgenographic records following the intravascular injection of radiopaque solutions have been devised, primarily for use in angiocardiology.¹⁻¹¹ Although a few such apparatuses are commercially available, most have been "home made," and as such have not received widespread application. In general, two principles have been followed: (1) rapid changing of cassettes, and (2) rapid photographic recording of roentgenoscopic images. The former is an inefficient method since it involves the shifting of heavy cassettes between each exposure. As a result, the interval between exposures has been longer than desirable and the maximum number of exposures limited by spatial considerations. In addition, apparatus capable of moving the weight of several cassettes has been of necessity heavy and not maneuverable. The photoroentgen method, while capable of producing a virtually unlimited number of exposures, has been hampered by the limitations of small film size and the distortion resulting from short target-screen distances. Its most valuable application is considered to be in the hospital where occasional angiocardiological study is contemplated and where the equipment may be employed both for angiocardiology and for routine chest photofluorographic examinations.

It was felt that the ideal apparatus would consist of a roll-film magazine in which only the essential element—the roentgen-ray film—would be transported. The device should be light weight and maneuverable so as to be adaptable to upright and prone angiocardiology as well as intra-

cranial arteriography. It should be so designed as to allow the use of the standard 6 foot target-film distance and standard roentgenologic equipment. With the cooperation of the Fairchild Camera and Instrument Corporation, such an apparatus has been devised and employed. This work has paralleled the efforts of Scott in St. Louis who employed a modification of

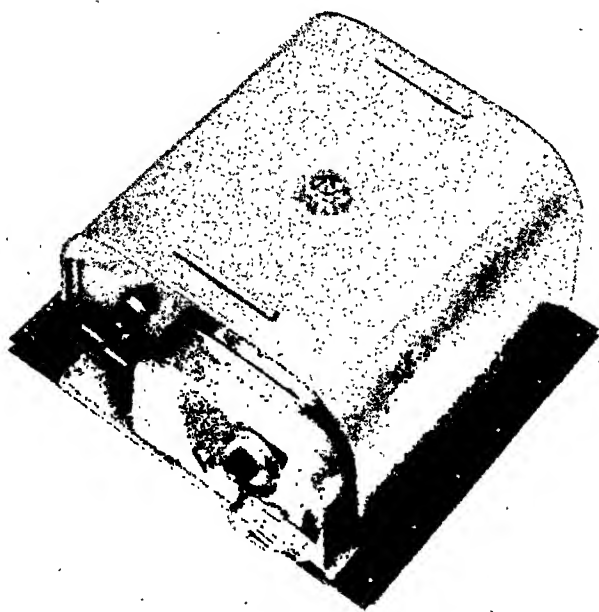


FIG. 1. Fairchild automatic roll-film magazine viewed from behind, cover plate in place.

the Fairchild 9 inch aerial camera magazine in conjunction with a self-cocking high-speed Bucky grid.¹¹

The magazine as employed by us is mounted upon a motor base plate which in turn is attached semi-permanently to a roentgen-ray table or other suitable support. The magazine (Fig. 1) is snapped into and out of the base plate for film loading and unloading in the darkroom.

* From the Department of Radiology of The New York Hospital-Cornell Medical Center.

† This study was aided by a grant from the Oren Root Estate.

An easily removable cover protects two film spools, each of capacity to hold 75 feet of film $9\frac{1}{2}$ inches in width. Two high-speed intensifying screens and a moving parallel grid are mounted on the front of the magazine and sheet lead protects the film supply from undesired exposure. A meter records the total number of films exposed. The magazine is equipped with a handle for easy carrying and weighs only 30 pounds, fully loaded, a weight equivalent

to that of three 14 by 17 inch standard cassettes. Loading and unloading is no more complicated than the similar operation on an ordinary roll-film camera.

The motor base plate consists of an aluminum plate behind which are mounted a $\frac{1}{15}$ horsepower electric motor with reduction gears, and the terminals for connecting electric leads. The outer dimensions of the motor base plate are 23 by 21 $\frac{3}{4}$ inches. With the magazine locked in place, the depth of the entire unit is 8 inches, and the weight is 49 pounds.

When the motor circuit to the magazine is closed from the roentgen-ray control panel the film is advanced 10 inches, then stopped by a clutch mechanism. A pressure plate sandwiches the film between the intensifying screens (which are mounted on felt pads) and the circuit to the roentgen-ray timer is closed, activating the roentgen exposure. The screens then are separated and the cycle is repeated every 0.5 second as long as motor current is supplied. During motor operation which is continuous, the parallel grid is kept in horizontal oscillation. A stationary fixed focus grid may be substituted for the moving parallel grid and is of particular use during intracranial arteriography.

We have employed the roll-film magazine mounted on a Philips pedestal Bucky stand (Fig. 2) allowing almost unlimited positioning and facilitating vertical or prone angiocardiology, intracranial arteriography, special studies during cardiac catheterization and cardiovascular visualization in the experimental animal (Fig. 3). A stretcher may be positioned over the magazine for prone angiocardiology and abdominal aortography. The device has afforded high quality, clearly defined roentgenograms in each application.

The duties of the technician during angiocardiology are simple. The magazine is actuated by a single control button and operation is automatic as long as the switch is held closed. The magazine may be run continuously for an entire cycle of contrast substance through the thorax. It may be run continuously during any selected period or periods of time or single exposures may be made at will. It has been convenient to operate the magazine during the first three seconds following the beginning of injection (obtaining studies of the right heart with its associated veins and arteries) and during the period of left heart opacification (between 7 and 10 seconds in the normal). A present, a 100 kv.(peak)

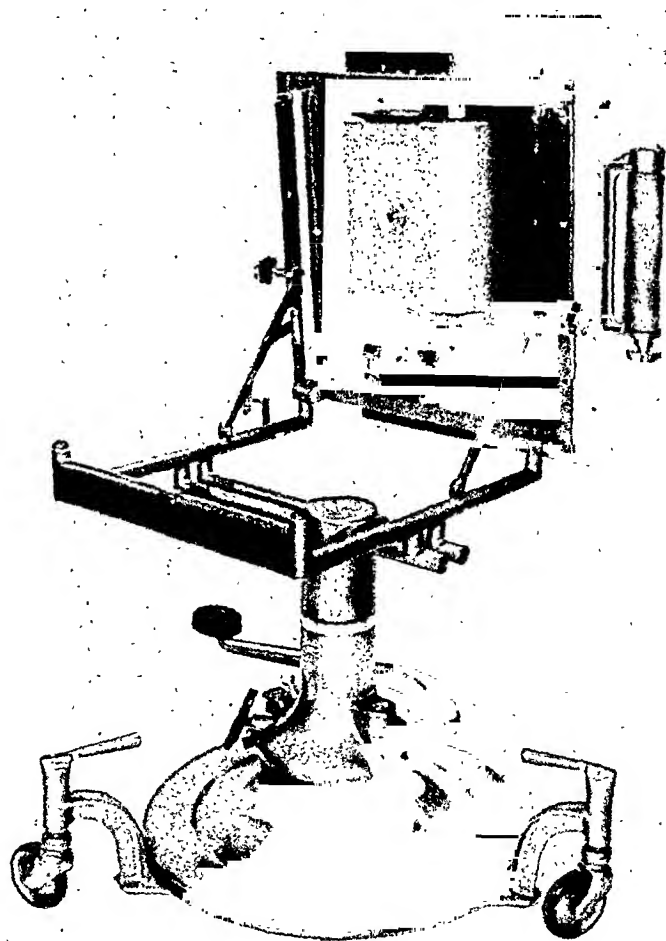


FIG. 2. Magazine mounted on motor base plate which is attached to Philips pedestal. Motor may be seen below magazine.

lent to that of three 14 by 17 inch standard cassettes. Loading and unloading is no more complicated than the similar operation on an ordinary roll-film camera.

The motor base plate consists of an aluminum plate behind which are mounted a $\frac{1}{15}$ horsepower electric motor with reduction gears, and the terminals for connecting electric leads. The outer dimensions of the motor base plate are 23 by

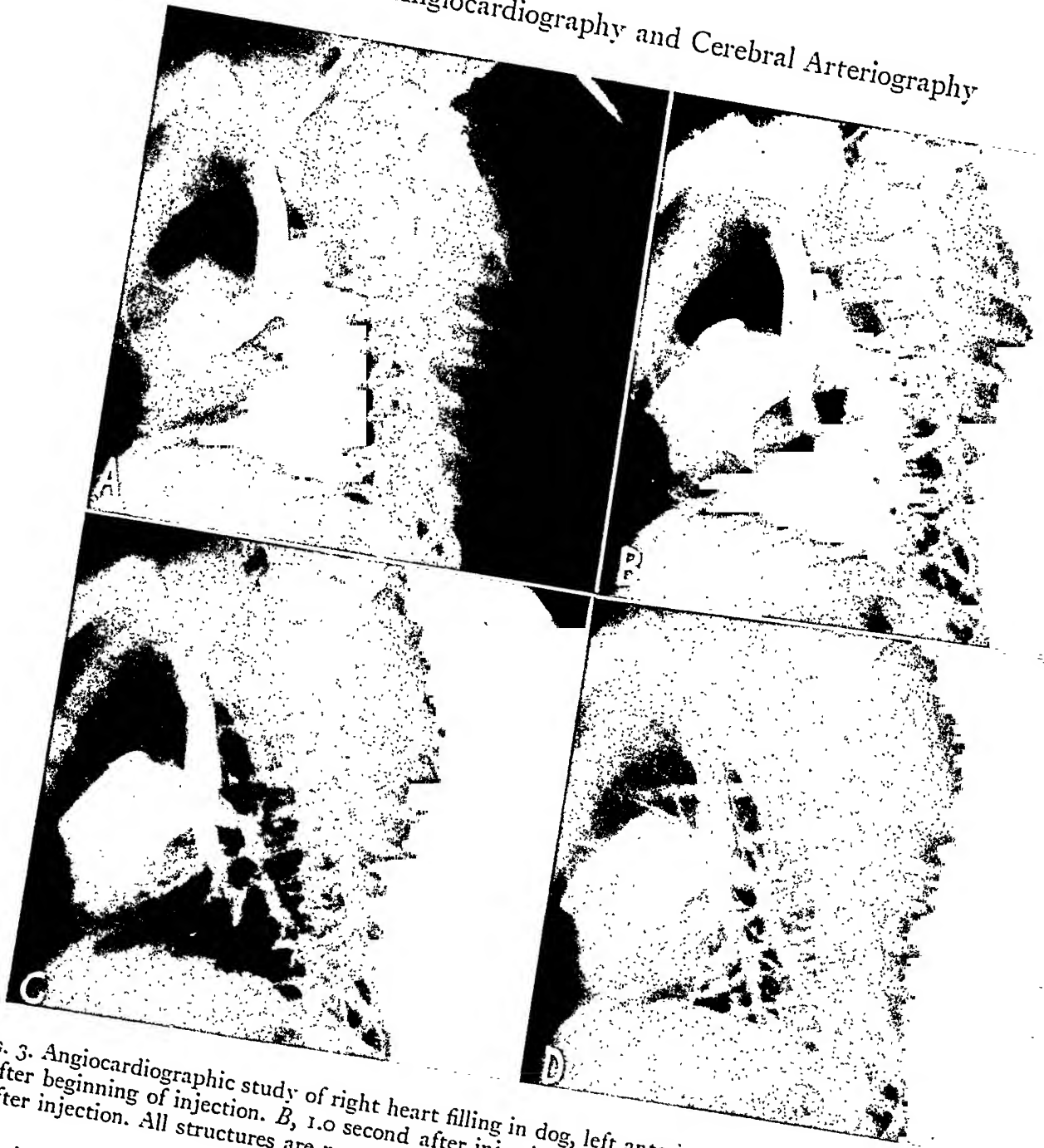


FIG. 3. Angiocardiographic study of right heart filling in dog, left anterior oblique projection. *A*, 0.5 second after beginning of injection. *B*, 1.0 second after injection. *C*, 1.5 seconds after injection. *D*, 2.0 seconds after injection. All structures are normal.

rotating anode tube is operated at 200 milliamperes. Exposure time of $1/10$ second is used at a kilovoltage suited to the projection employed and the size of the patient. In the near future, modifications in timing apparatus now being made will allow $1/60$ second exposures at 500 ma. All angiocardiography is done at 6 foot distance in the interest of uniformity and to minimize distortion. Intracranial arteriography and abdominal aortography is performed at 40 inch distance using a moving fixed-focus grid.

Actual measurements made with an ionization chamber reveal that the patient receives a total of 4.5 roentgens (average) during a twenty-four exposure run. This is considered to be within safe limits. The amount of radiation received by the doctor making the injection (protected by a long apron or a lead screen) falls within the allowable limits for such exposure. Calculation of heat units indicates that a run of twenty-four consecutive exposures during a 12 second time does not exceed the tube limits (rotating anode tube).

Double emulsion du Pont roentgen-ray film made up by the manufacturer in 75 foot rolls has proved satisfactory in our experience, as have other standard brands of roentgen-ray films. Recommended time-temperature development is carried out using the Fairchild X-Ray Film developing unit. Following developing, fixing and washing, the film may be conveniently dried as a long strip draped over hangers in the film dryer.

The resultant exposed films measure $9\frac{3}{16}$ by $9\frac{7}{16}$ inches in size. It would be desirable to have a slightly larger film size than is at present available, but by roentgenoscopy of the patient prior to angiocardiology, satisfactory positioning may be easily obtained.

It is believed that this magazine presents the best available means of angiocardigraphic recording and that eventual refinements will be directed along the principles it employs. The unit is commercially available. Other planned applications of the apparatus include uterosalpingography, special studies of gastrointestinal motor function and electrocardiographically controlled contrast studies of cardiac chamber volume and wall thickness. The small size of the unit will allow the use of two tubes and two magazines in order to obtain simultaneous recording in two projections. Further modes of application are expected to widen the usefulness of this device beyond the scope of this initial preliminary report.

The New York Hospital
525 East 68th St.
New York 21, N.Y.

REFERENCES

1. ROBB, G. P., and STEINBERG, I. Visualization of the chambers of the heart, the pulmonary circulation, and the great blood vessels in man; practical method. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, *41*, 1-17.
2. STEWART, W. H., BREIMER, C. W., and MAIER, H. C. Contrast cineroentgenography of the circulatory organs. *New York State J. Med.*, 1941, *41*, 1174-1176.
3. SCHWARZSCHILD, M. M. A multiple cassette changer for angiocardiology. *Radiology*, 1942, *40*, 72-74.
4. SUSSMAN, M. L., STEINBERG, M. F., and GRISHMAN, A. Rapid film changer for use in contrast angiocardiology. *Radiology*, 1942, *38*, 232-233.
5. NEUHAUSER, E. B. D., and JENNINGS, C. G. Inexpensive cassette changer for angiocardiology. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, *49*, 829-830.
6. SUSSMAN, M. L. A review of angiocardiology. *Advances in Internal Medicine*. Interscience Press, New York, 1947.
7. BROCKLEBANK, J. A. Angiocardiology applied to congenital heart disease: observations on the radiology and technique. *Brit. J. Radiol.*, 1948, *21*, 393-397.
8. TEMPLE, H. L., STEINBERG, I., and DOTTER, C. T. Angiocardiology utilizing photoroentgen apparatus with a rapid film changer. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, *60*, 646-649.
9. TAYLOR, H. K. An apparatus for automatic multiple exposures. *Radiology*, 1949, *52*, 107-111.
10. SISSON, M. A. A rapid cassette changer for angiocardiology. *Radiology*, 1949, *52*, 419-422.
11. SCOTT, W. G. Angiocardiology with a nine inch roll film camera. Exhibited at the Thirty-Fourth Annual Meeting of The Radiological Society of North America, San Francisco, Calif., December, 1948.



GENERALIZED PROGRESSIVE SCLERODERMA*

REPORT OF AN INSTANCE OF ESOPHAGOSCOPIC PERFORATION OF THE ESOPHAGUS WITH DESCRIPTION OF THE ROENT- GENOLOGICAL AND NECROPSY FINDINGS

By GERHART S. SCHWARZ, M.D.†

CLIFTON SPRINGS, NEW YORK

and

OLAF K. SKINSNES, M.D., Ph.D.‡

NEW YORK, NEW YORK

FEW instances of sclerodermatic stricture of the esophagus correctly diagnosed roentgenologically and proved by necropsy have been reported. Lindsay *et al.*⁶ state, in their recent review of the literature, that postmortem examinations of this lesion have been reported in only 3 instances. Olsen *et al.*,⁹ in a later review, which includes the preceding 3 reports, found 8 cases with necropsy findings described. All revealed pathological changes in the esophagus attributable to scleroderma. No definite reference was made to the presence or absence of stricture, however. An additional report has since been added by Goetz.¹ The following report is presented as an additional necropsy study because of its roentgenological interest centering about a complicating esophageal perforation, the true nature of which was revealed only at autopsy.

CASE REPORT

Clinical History. W. S., a married woman, aged sixty-seven, prominent in political activities and of Irish extraction, was admitted to the University of Chicago Clinics on January 1, 1945, five years following a diagnosis of Reynaud's disease which was based on progressive ulceration of the fingers. In the interim she had been active and well save for this affliction which was not incapacitating. Six weeks prior to her final hospitalization she began to note shortness of breath associated with the eating of solid foods and relieved by

regurgitation. She also noted difficulty in swallowing, retrosternal pain, coughing, and frequent regurgitation of gastric contents without nausea. These symptoms persisted and her physician reported roentgenoscopic and roentgenologic evidence of lower esophageal stricture with proximal dilatation. His report did not mention any upper esophageal lesion. Further examination, by esophagoscopy with biopsy, performed on December 19, 1944, two weeks prior to terminal hospitalization, was reported as suggestive of epidermoid carcinoma of the esophagus with associated inflammation. These biopsy sections were later reviewed at the University of Chicago Clinics and deemed non-neoplastic. The only anesthetic used at esophagoscopy was a spray. Following this procedure the patient experienced slight swelling and soreness of the throat and increased difficulty in swallowing for some days.

At the first roentgen examination in the University Clinic, on January 2, 1945, amputation (probably spontaneous) of the terminal phalanx of the second digit of the left hand and osteo-arthritis involving many digits of both hands were noted (Fig. 1). Barium study of the esophagus by roentgenoscopy and roentgenography revealed a fusiform narrowing of its lower third and dilation of its middle portion (Fig. 2 and 4). Sclerodermatic stricture of the esophagus was diagnosed on the basis of the smooth fusiform appearance of the esophageal stricture and its association with the digital lesions.

The roentgen studies also disclosed a 10 cm. long, spoon-shaped pouch lying dorsal to the upper third of the esophagus (Fig. 3 and 4).

* From the Division of Roentgenology and the Department of Pathology, the University of Chicago, Chicago, Illinois.

† Department of Radiology, Clifton Springs Sanitarium and Clinic, Clifton Springs, N. Y.

‡ Now Department of Pathology, Cheeloo University, Foochow, Fukien, China.

Acknowledgment is gratefully made of the permission of Dr. D. B. Phemister to publish this case, of the helpful suggestions of Drs. P. C. Hodges, J. R. Lindsay, E. M. Humphreys, and P. R. Canon, and of the careful work of Miss R. C. Winkler in the preparation of the histopathological sections.

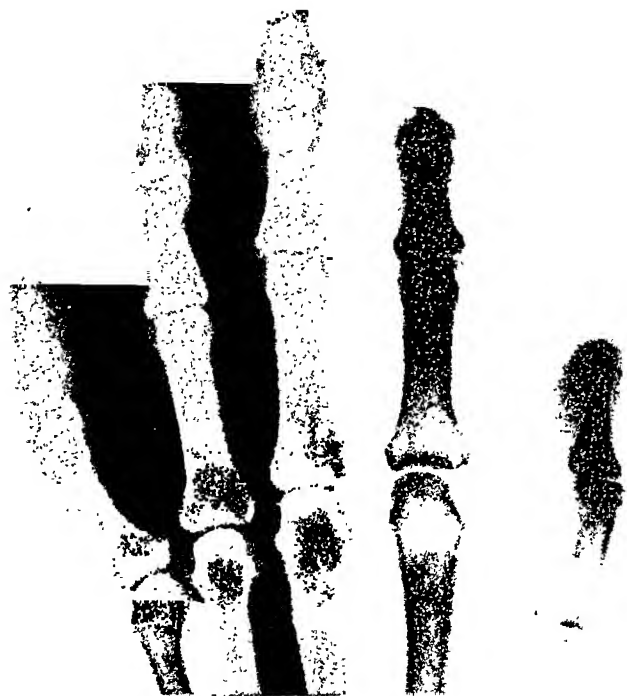


FIG. 1. Roentgenogram of the patient's left hand. There is auto-amputation of the distal half of the distal phalanx of the second digit and minor osteoarthritic changes are seen in several of the joints.

This pouch filled with barium when the patient tipped her head back while swallowing. This act was invariably accompanied by coughing. Communication between the pouch and the esophagus was by a narrow isthmus not more than 5 mm. wide which lay at the level of the sixth cervical vertebra. The location of the pouch and the smoothness of its walls suggested the diagnosis of a diverticulum, possibly of Zenker's type, despite a suggestion by the referring service to the effect that it might represent esophageal perforation by esophagoscopy with leakage of barium into the soft, retro-esophageal tissues. Subsequent roentgen studies of a coincident pulmonary infection performed five days later indicated that the barium had escaped from the pouch. This complete disappearance of the contrast material was interpreted as additional indication of the diverticular nature of the lesion. Under sulfadiazine and penicillin therapy the pulmonary infection subsided and the leukocyte count dropped from a previous high of 20,500 to 9,500 by the day of operation. A urea clearance test indicated renal function of 46 per cent of the mean normal ($U/B\sqrt{T} = 25.8$), but other laboratory tests were negative. At a preoperative roentgen study of the esophagus on

January 24, 1945, barium failed to enter the previously seen pouch. It was assumed that this failure to visualize the lesion twenty-two days after it was first seen indicated that its narrow isthmus had closed.

Diffuse inflammation of the esophagus up to the level of the lung hila was noted on the thirty-sixth hospital day when a transthoracic, side-to-side esophagogastrostomy was performed to relieve the patient's difficulty in swallowing. On the first postoperative day she vomited and aspirated gastric contents. Her temperature rose to 39° C. and remained at about this level thereafter. On the second postoperative day she was oliguric and her reduced blood pressure necessitated a blood transfusion. No reaction was noted but subsequently she became slightly icteric. Signs of aspirative bronchopneumonia, were present. On the third day she again aspirated vomitus and died early on the fourth day with continued evidence of respiratory distress despite chemotherapy, bronchoscopic



FIG. 2. Fusiform stricture of the lower third of the esophagus demonstrated on the roentgenogram.

aspiration and other therapeutic and supportive measures.

Necropsy Findings (Autopsy 6426). Post-mortem examination was performed six hours after death. The skin was generally fair and soft but slightly icteric above the level of the navel. The body was well nourished. The index finger of the left hand lacked the terminal phalanx and the overlying skin was taut, puckered and indurated. That covering the terminal phalanges of the other fingers showed similar induration but no ulceration. The finger nail of the fourth right digit was loosened and at its base new nail growth was evident. Histopathologically the skin of the chest and abdomen was not remarkable. That of the



FIG. 3. Cervical esophagus at the first roentgenological examination. The retouched roentgenogram shows the spoon-shaped, retro-esophageal pouch filled with barium and communicating with the esophagus by a narrow neck at the level of C₅—C₆. Its contours are smooth.

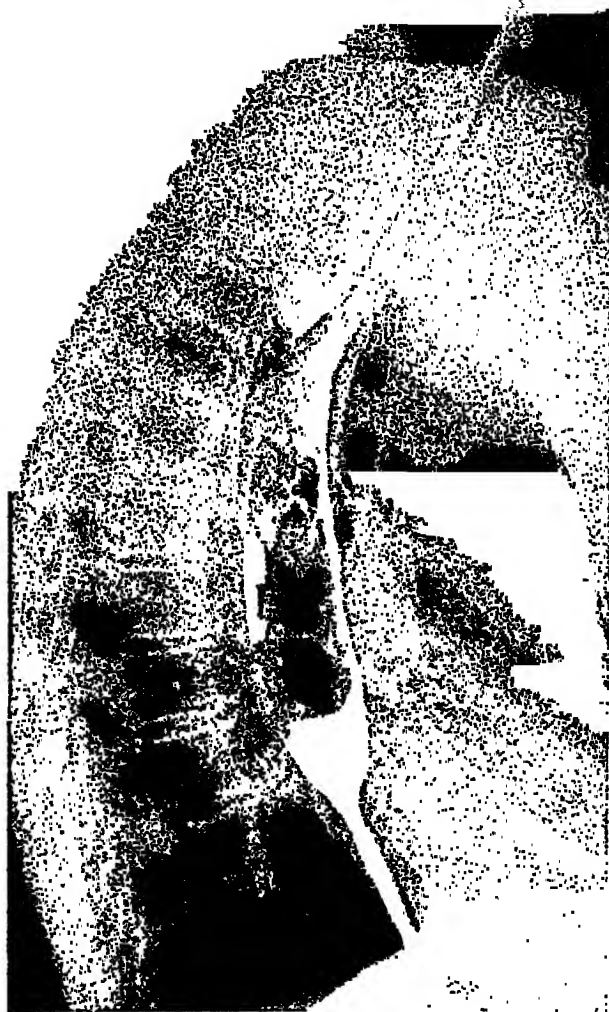


FIG. 4. Left lateral view of the entire esophagus obtained at the first roentgenological examination. Patient standing. Upper portion slightly retouched. The upper end of the neck of the retro-esophageal pouch appears as in Figure 3. The lower end appears to have a second communication with the esophagus which may be due to an overlapping of both structures since there is no assurance that this represents a true profile view. Retropharyngeal air appears to be present above the neck of the pouch or pseudo-diverticulum. The esophagus is dilated above the distal stricture and contains air and food particles.

sclerotic finger tips displayed moderate collagenous sclerosis of the corium with hyalinization of the collagen bundles. A few of the underlying arterioles contained antemortem thrombi and the epidermis was thickened and slightly hyperkeratotic.

Lying at the level of the cricoid cartilage on the posterior wall of the esophagus was a 3 mm. deep outpouching which, on microscopic examination, was seen to extend through the



FIG. 5. Esophagus and stomach showing esophageal stricture, esophagogastrostomy, esophageal leukoplakia, upper esophageal outpouching, and lower esophageal outpouching.

tunica muscularis and to end blindly, being lined with squamous epithelium (Fig. 5 and 6). Five and a half centimeters directly below it there was a similar but slightly more shallow outpouching having similar microscopic characteristics but extending only to the tunica muscularis (Fig. 5 and 7). Grossly the retro-esophageal connective tissue lying between these two outpouchings was thicker and denser than the peri-esophageal tissue found elsewhere. Sections through this cord of tissue after fixation disclosed a small flattened lumen beginning at about the level of the upper outpouching and

extending downward toward the lower outpouching for about 2.5 cm. Microscopically, in multiple sections, this lumen was found to lie entirely outside of the tunica muscularis (Fig. 8). It was collapsed, having a greatest diameter of about 7 mm. Its wall was composed of granulation tissue in which food particles of vegetable origin and foreign body giant cells were scattered. A few, relatively large blood vessels lay perilously close to the lumen. This pseudo-diverticulum was completely devoid of epithelial lining save for a small focus at its upper pole where there was a discontinuous, two cell thick layer of squamous epithelium. This lay close to the epithelium of the upper outpouching but it was not possible to demonstrate any direct connection between the two. The lumen of the pseudo-diverticulum contained a small amount of amorphous, protein-like matter, numerous bacterial colonies and



FIG. 6. Histopathological section of the upper esophageal outpouching illustrating its close proximity to the upper portion of the pseudo-diverticulum. There is extensive surrounding fibrosis. Heidenhain's modification of Mallory's connective tissue stain. $\times 23$.

FIG. 7. Histopathological section of the lower esophageal outpouching. There is intense surrounding fibrosis and disruption of the muscular coats. The pseudo-diverticulum site is represented by dense fibrous tissue lying external to the tunica muscularis. Heidenhain's modification of Mallory's connective tissue stain. $\times 27$.



occasional inflammatory cells but no desquamated epithelial cells. The upper esophageal outpouching was connected to the lumen of the pseudo-diverticulum by a dense band of collagenous fibrous tissue extending through the tunica muscularis (Fig. 6). In its lower portion the pseudo-diverticulum was obliterated by fibrous tissue and its connection with the lower esophageal outpouching was represented by a dense band of fibrous tissue (Fig. 7).

Twelve and a half centimeters above the cardia the esophageal epithelium, which above this level showed only microscopic foci of leukoplakia, began to show clear-cut leukoplakic thickening. Grossly and microscopically this became progressively more pronounced toward the lower esophagus achieving a thickness three to four times that prevalent in the upper third. One millimeter wide erosions extending in all directions, but predominantly vertically, divided the leukoplakic epithelium into islets of various sizes and shapes having

diameters averaging roughly 5 to 7 mm. The greatest esophageal circumference of 6.5 cm.



FIG. 8. Histopathological section of the pseudo-diverticulum illustrating its granulation tissue wall, its close proximity to a large vein, and the only area of epithelial lining found in the lesion. This epithelial layer was present in the upper portion of the pseudo-diverticulum, was discontinuous and presumably arose from displaced esophageal epithelium. Hematoxylin-phloxin stain. $\times 32$.

lay 7 cm. above the cardia. The terminal esophagus displayed a 2.5 cm. long stenotic passage having a circumference of 2.3 cm. (Fig. 5). Just above this stenotic passage there was a side-to-side esophagogastrostomy, the suture lines of which showed good healing save for a 4 mm. opening lying posteriorly in friable, discolored, necrotic tissue and communicating through the posterior mediastinum with an extensive fibrinopurulent left pleural empyema cavity.



FIG. 9. Histopathological section of the esophagus illustrating the esophageal leukoplakia, epithelial erosion, submucosal fibrosis and fibrous atrophy of the inner circular layer of the tunica muscularis. Hematoxylin-phloxin stain. $\times 82$.

Microscopically the upper esophageal epithelium showed occasional minute intraepithelial acute abscesses and eroded foci with underlying acute focal inflammatory changes. The progressively increasing leukoplakia in the lower esophagus was increasingly frequently interrupted by more extensive areas of ulceration with underlying acute inflammation. The muscularis mucosae gave the impression of

being slightly hypertrophic, especially in the lower esophagus, but it was repeatedly disrupted by the inflammatory changes underlying the epithelial erosions, and by the submucosal fibrosis. The submucosa was characterized by dense hyalin fibrous sclerosis with decreased cellularity, more marked in the lower portion of the organ. The tunica muscularis showed remarkable atrophy of the smooth muscle fibers and encroachment of fibrous tissue at the interdigitation of the smooth and striated muscle fibers in the upper esophagus. Similar changes were not noted in the striated muscle. The inner circular layer of smooth muscle, in contrast to the outer longitudinal layer, was generally atrophic throughout the esophagus and displayed marked fibrous encroachment (Fig. 9). At the cardio-esophageal stricture the epithelium was largely sloughed and the immediately underlying tissue showed subacute inflammatory changes characterized by lymphocyte and plasma cell infiltration. The submucosa revealed extremely dense fibrous sclerosis with hyalinization and disruption of the muscularis mucosae and extension of the fibrotic sclerosis into the tunica muscularis. The included arterioles were sclerotic and sclerosis of the smaller arteriolar radicals was prominent throughout the lower esophagus.

Elsewhere the alimentary tract was not remarkable.

Increased fibrosis was evident in many other areas of the body though the homogenization frequently described as a characteristic of sclerodermic fibrosis was not noted. The renal capsule displayed striking fibrosis with little cellularity and the glomeruli showed fine disseminated intercapillary fibrosis not unlike that seen in the intercapillary sclerosis associated with diabetes save for the lack of formation of hyalinized balls of connective tissue. The epicardium showed similar hyalinized fibrosis with decreased cellularity far antedating the overlying acute fibrinous pericarditis, and the myocardium contained scattered foci of hyalin fibrosis. Atrophic muscle fibers and arterioles were often included in these areas of fibrosis though the fibrosis was not invariably associated with blood vessels. The endocardium likewise showed occasional small foci of fibrous thickening.

In addition to the above findings and the evidences of the surgical procedures the anatomical diagnosis included the following: left

thoracic fibrinopurulent empyema, fibrinous pericarditis (non-hemolytic streptococci and *B. coli*), left pulmonary atelectasis, bilateral aspirative bronchopneumonia and bronchitis, myeloid hyperplasia remarkable for the relative increase in eosinophils.

DISCUSSION

During the past few years it has become increasingly evident that running through the varied clinical and pathological pattern of generalized progressive scleroderma lies a basic sclerosing change in the connective tissue of as yet unknown etiology. Together with the knowledge that the varied symptomatology is to a large extent based on the localization of the process and its severity, greater attention has been focussed on the esophagus, as well as other portions of the alimentary system, as a not infrequent site of severe change. Despite this there have been few recorded opportunities for histopathological investigation of this change.^{1,5,6,13,20}

The nature of the esophageal lesion responsible for the presenting symptoms was readily established antemortem in the instance here described. Roentgenologic interpretation of the esophageal stricture was not problematic. Its smooth contours, fusiform shape, and association with destructive terminal finger lesions suggested esophageal scleroderma. The necropsy findings of mucosal erosion, submucosal fibrosis, hypertrophy of the muscularis mucosae, fibrous atrophy of the inner layer of the tunica muscularis, and the marked leukoplakia confirmed the diagnosis of scleroderma (or progressive systemic sclerosis). The increasing severity of these changes in the distal portion of the esophagus lends support to the suggestion of Lindsay *et al.*⁶ that these changes may be largely secondary to a primary disturbance of esophageal function leading to regurgitation of gastric contents with a resultant peptic esophagitis and gross anatomic changes. Esophageal leukoplakia is often seen in association with chronic esophagitis (Templeton)¹⁹ and the progressively increasing severity of the

lesion toward the cardia in this instance supports this concept. In view of the widespread tendency toward fibrosis evinced by this disease process, it may be that the marked esophageal sclerosis represents an exaggerated response to the chronic trauma of regurgitation, or on the other hand, the esophagitis may serve to provide a locus minoris resistentiae allowing increased local activity of whatever etiologic agent is involved.

The nature of the retro-esophageal pouch was more obscure. Its smooth contours and location were characteristic of a diverticulum, possibly of Zenker's type, but it was recognized that it is unusual for an upper esophageal diverticulum to be so long and narrow. Usually they are rounded and do not dissect along the esophagus. The reported failure to visualize the lesion on pre-esophagoscopy roentgenoscopy together with repeated failures to revisualize it on later examinations bespoke its temporary nature and suggested the esophagoscopy examination as being its traumatic cause. No statement has been found in the literature which mentioned failure of a subpharyngeal diverticulum to fill once it has been visualized. Such a possibility is conceivable should the diverticulum have as small a neck as that described in this instance since the opening could be occluded by food particles or mucus, or could possibly be strangulated by torsion. The absence of retro-esophageal emphysema spoke against a recent perforation. Possibly too much time elapsed between the time of injury and that of examination to allow demonstration of this sign. A solitary collection of air behind the pharynx was, probably correctly, interpreted as having accumulated in the upper portion of the pseudo-diverticulum.

Recognition of traumatic perforation of the esophagus by extravasation of contrast material into the mediastinum is rare. Most reports have concerned a single case often included in a series of perforated esophagi recognized by other means or by other roentgen signs.^{4,8,10,15,17} One reason for this

is the hesitation with which barium is given in such instances, the objections being largely surgical (e.g., fear of obscuring esophagoscopic or operative fields, interference with the healing of mediastinal abscess due to the presence of foreign body material). Some authors,^{3,7,10,15,18} however, do not raise any objection to the procedure.

The difficulties of esophagoscopy in patients with scleroderma are not sufficiently well recognized. It is becoming increasingly apparent from instances such as this that esophagoscopic procedures in these patients are safest when carried out under general anesthesia.

A case reported by Robinson¹⁴ is similar to that here reported in the nature of the perforation. A barium filling, retro-esophageal pouch was observed in the cervico-thoracic region of a young woman nine days after esophagoscopy for the removal of a swallowed bone. The pouch had ragged, scalloped borders. Its size, shape and location were almost identical with those of the present report. A week later no barium rest could be visualized in the region and repeated attempts to refill the pouch with barium failed. Following esophagoscopy chest symptoms and a mild fever developed but a month later the patient recovered completely without surgical intervention.

In the presently reported instance the abscess had apparently emptied into the esophagus spontaneously through the lower perforation, leaving as a scar a small esophageal outpouching, and thus imitating well the surgical treatment for peri-esophageal mediastinitis inaugurated by Seiffert¹⁶ which consists of longitudinal slitting of the gullet through the esophagoscope.

SUMMARY

Roentgenologic and necropsy findings in an instance of lower esophageal stricture associated with digital lesions and diagnosed as esophageal scleroderma are reported. A retro-esophageal pseudo-divertic-

ulum occurring as a result of esophagoscopic examination is likewise described and illustrated. The differential diagnosis and implications of the perforation are discussed.

Gerhart S. Schwarz, M.D.
Clifton Springs Sanitarium and Clinic
Clifton Springs, N.Y.

REFERENCES

1. GOETZ, R. H. Pathology of progressive systemic sclerosis (generalized scleroderma) with special reference to changes in viscera. *Clin. Proc.*, 1945, 4, 337-392.
2. HALE, C. H., and SCHATZKI, R. Roentgenological appearance of gastrointestinal tract in scleroderma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 407-420.
3. IGLAUER, S., and RANSOHOFF, J. L. Perforation of esophagus by foreign body with report of a case presenting unusual x-ray signs. *Laryngoscope*, 1924, 34, 821-825.
4. KINDLER, W. Ungewöhnliche Verwicklungen nach Oesophagusverletzungen durch Fremdkörper und anderes nebst einigen röntgendiagnostischen Bemerkungen. *Ztschr. f. Hals-, Nasen- u. Ohrenh.*, 1927, 19, 1-14.
5. KURE, K., YAGAMATA, K., TSUKADA, S., and HIYOSHI, J. Passagestörung des Oesophagus bei Sklerodermie und Dystrophia musculorum progressiva. *Klin. Wchnschr.*, 1936, 15, 516-520.
6. LINDSAY, J. R., TEMPLETON, F. E., and ROTHMANN, S. Lesions of esophagus in generalized progressive scleroderma. *J.A.M.A.*, 1943, 123, 745-750.
7. MANGES, W. F. Roentgen diagnosis of foreign bodies in the esophagus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1927, 17, 44-50.
8. MCGINNIS, E. Personal experiences in bronchoscopy and esophagoscopy during the past year. *Illinois Med. J.*, 1924, 45, 42-47.
9. OLSEN, A. M., O'LEARY, P. A., and KIRKLIN, B. R. Esophageal lesions associated with acrosclerosis and scleroderma. *Arch. Int. Med.*, 1945, 76, 189-200.
10. PHILLIPS, C. E. Mediastinal infection from esophageal perforation. *J.A.M.A.*, 1938, 111, 998-1004.
11. PUGH, D. G., KYALE, W. F., and MARGULIES, H. Scleroderma with involvement of the viscera; report of case. *Proc. Staff Meet., Mayo Clin.*, 1945, 20, 410-414.
12. RAFSKY, H. A., and HERZIG, W. Scleroderma with oesophageal symptoms; report of two cases. *Gastroenterology*, 1946, 6, 35-39.

13. RAKE, G. On the pathology and pathogenesis of scleroderma. *Bull. Johns Hopkins Hosp.*, 1931, 48, 212-227.
14. ROBINSON, CECILIE. Posttraumatische Eiterhöhle als Pseudodivertikel des Ösophagus. *Röntgenpraxis*, 1937, 9, 126-127.
15. SCHIFFER, E. Die Bedeutung der Röntgenuntersuchung beim Verdacht auf Perforation der Speiseröhre durch verschluckte Fremdkörper. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1935, 51, 555-564.
16. SEIFFERT, A. Oesophagusschlitzung zur Behandlung frischer vom Oesophagus ausgehender Verletzung des Mediastinums. *Arch. f. klin. Chir.*, 1928, 150, 569-576.
17. SIMEONI, C. Stenosi esofagea da caustico alcalino complicata a diverticolo traumatico fistolizzato in corrispondenza del giugulo. *Arch. ital. di otol.*, 1931, 42, 609-617.
18. SPIESS, G. Forderung nach frühzeitiger Röntgendurchleuchtung mit Kontrastmitteln bei verschluckten Fremdkörpern. *Ztschr. f. Hals-, Nasen- u. Ohrenh.*, 1928, 21, 527-531.
19. TEMPLETON, F. E. X-ray Examination of the Stomach. University of Chicago Press, Chicago, 1944.
20. WEISSENBACH, R. J. *et al.* Un cas de syndrome de Thibierge-Weissenbach (sclérodémie progressive et calcifications) avec lésions buccopharyngées et oesophagiennes accentuées, ayant nécessité la gastrostomie. *Bull. Soc. franç. de dermat. et syph.*, 1937, 44, 1053-1060. Also, Sclerodermie progressive. *Ibid.*, 1937, 44, 2018-2024.



ULCER ASSOCIATED WITH DIAPHRAGMATIC HERNIA*

By GLENN F. MILLER, M.D., and HOWARD P. DOUB, M.D.
Department of Roentgenology, Henry Ford Hospital
 DETROIT, MICHIGAN

CAREFUL roentgenographic examination of large numbers of the general population has disclosed the fact that diaphragmatic hernia is a common anatomic abnormality. The roentgen characteristics of this condition have long been familiar, and the symptoms and signs constitute a fairly definite clinical syndrome. In many cases the hernia is small and is regarded merely as an incidental finding, without clinical significance. In other cases, however, especially where the hernial sac is large, there is a strong probability that it is of distinct importance, and a painstaking roentgenoscopic and roentgenographic study is indicated to evaluate its relation to the clinical picture.

The discovery of a small series of gastric ulcers associated with diaphragmatic hernia has raised the question of the incidence of this association, and has suggested that it may be more frequent than was previously thought. It is believed, also, to constitute a definite problem from the point of view both of symptoms and treatment.

The term diaphragmatic hernia is commonly used to designate the protrusion of any of the abdominal contents through an abnormal opening in the diaphragm or through an enlargement of the esophageal or other normal hiatus. Three main groups are usually recognized: (a) congenital, due to an embryologic deficiency, usually without an enclosing sac; (b) acquired, in most cases as a result of dilatation or relaxation of a hiatus in the diaphragm, and when occurring through the esophageal hiatus, usually provided with an enclosing sac; (c) traumatic. Some authors would include this last group with the acquired hernias, but others believe it should be considered separately, comprising those cases due to

accident, operation or rupture secondary to subdiaphragmatic abscess. Hume⁷ believed that thoracic stomach with short esophagus should not be included in the foregoing classification, since the stomach in such cases has never been an abdominal organ and herniation does not enter into the picture. Eventration may also be excluded, as in this condition the stomach remains below the diaphragm.

In our study of 290 cases of diaphragmatic hernia at the Henry Ford Hospital, we have found herniation through the esophageal opening to be the most frequent type in the adult, an observation in accord with that of Harrington and Kirklin,⁶ and others. These hernias are most often non-traumatic and have an enclosing sac. Åkerlund¹ called them "hiatus hernias" and divided them into three groups including the short esophagus cases. His classification is as follows: (a) congenital short esophagus with partial or complete thoracic stomach; (b) esophageal hiatus hernia with an esophagus of normal length which does not form a part of the hernia, that is, paraesophageal hernia, and (c) hiatus hernias not included in (a) and (b).

In 1929 Collier *et al.*,² in a review of the literature, found only 3 cases of diaphragmatic hernia associated with a chronic gastric ulcer. The first case, a description of which they include, was published by Bright in *Guy's Hospital Reports* in 1836. The patient was subject to attacks of sudden dyspnea and indigestion, and lying on the left side frequently caused vomiting. Death resulted from exhaustion after a long period of vomiting and dyspnea. Autopsy revealed a diaphragmatic hernia, with the stomach filling the lower portion of the thoracic cage, and two or three deep

* Presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

chronic ulcers on the lesser curvature. The second case was reported by Hoffmann, of Heidelberg, in 1917 and was believed to be traumatic in origin, following a heavy fall resulting in several fractured ribs. Six weeks after this accident the patient suffered from indigestion for the first time and vomited dark clots. There ensued a twelve year period of vomiting and indigestion which became progressively severe and frequent, with a hemoglobin of 55 per cent at the time of death. A diaphragmatic hernia was found at autopsy, with an ulcer on the lesser curvature side of the stomach. The third report was by Key, of Stockholm, in 1924, who apparently was the first to demonstrate roentgenographically a case of diaphragmatic hernia associated with ulcer which was later proved at operation. To these cases Collier and his associates added 2 more which they demonstrated roentgenographically. In each instance there was a left diaphragmatic hernia containing about one-third of the stomach and showing a large crater on the lesser curvature, just below the diaphragm where it was constricted by the hernial orifice. Both cases were proved at autopsy.

Truesdale,¹³ in 1932, found listed in the literature 17 cases of ulcer of the herniated stomach and reported one of his own, bringing the total to 18. His analysis of this series disclosed that 10 occurred in males and 8 in females, the age ranging from nineteen to sixty-eight years, with an average of forty-four plus. In 15 of the cases the hernia was of the esophageal hiatal type and in 14 of these an ulcer was present on the lesser curvature of the stomach at the hiatal narrowing. There was one hernia through the orifice for the vena cava and one through the foramen of Bochdalek. The remaining case was one of congenital short esophagus. The type of ulcer varied from a small niche to multiple perforating lesions. In one case the ulcer eroded a branch of the pulmonary artery causing a fatal hemorrhage.

Four cases have appeared since Truesdale's review, bringing the total to 22.

Sangster,¹⁰ in 1936, presented a case in which at autopsy there was found a hernia through the tendinous portion of the diaphragm into the left pleural cavity, containing the transverse colon, stomach, and 25 cm. of jejunum. On the lesser curvature of the stomach was an ulcer which had perforated. In 1941 a case was reported by Frank and Hamilton⁴ in which the defect was just to the left of the esophageal hiatus and the hernia contained a portion of the stomach, with a large penetrating gastric ulcer, and a part of the transverse colon. Two other cases, of the hiatal hernia type with an ulcer present in the area of narrowing, were reported by Steiner¹² in 1946.

Like Åkerlund, we have regarded the congenital short esophagus with thoracic stomach not as a separate entity but as a subdivision of hiatus hernia, to which it is related embryologically, the rate of descent of the stomach during the formation of the diaphragm being the determining factor. According to Shanks,¹¹ the rate of descent determines whether the stomach may be trapped by the diaphragm and become partially thoracic in location or, if the lag is slighter, may produce only a slight enlargement of the esophageal orifice.

From a review of the literature we assembled 38 cases of congenital thoracic stomach with an ulcer present in the short esophagus at its point of junction with the cardia. Seven cases of esophageal ulcer associated with a gastric hiatus hernia were also found. The age range in this collected series was from forty-five to sixty-eight years, with the exception of one case occurring in a three year old child. The sex incidence was approximately equal. Six cases were demonstrated roentgenographically and in 37 there was some indication of gastric bleeding, hematemesis, occult blood in the stools, tarry stools, or anemia.

Ulcers occurring in the short esophagus associated with the thoracic stomach have generally been conceded to be the result of the action of acid gastric juice on the stratified squamous epithelium of the esophagus, which cannot withstand its eroding action.

The acid gastric juice reaches this area by regurgitation, explained by Dick and Hurst³ as being due to the loss of the valvular mechanism normally present at the cardia when it is situated in the abdomen. The action of this gastric regurgitation is abetted by the presence of islets of gastric mucous membrane, which have been found in the lower end of the esophagus by Jackson.⁸

Ulcers which occur in conjunction with true hiatal hernias are considered by Rude,⁹ Truesdale,¹³ and others, to be primarily the result of irritation and trauma to the stomach wall by the constricting action of the hiatal orifice, which leads to congestion, varicosities, disturbance of the arterial blood supply, and eventually to erosion and active ulcer. Other factors are the strain produced in the act of vomiting and the presence of the active secreting glands, which are more abundant on the lesser curvature side of the stomach. These observations appear to be borne out by Harrington's⁵ series, in which he has found all stages of involvement from superficial erosion of the gastric mucosa to definite ulcer formation with a well defined crater.

The symptomatology of ulcer associated with hiatal hernia is dependent upon the extent of the herniation, the degree of constriction produced by the hernial opening, and the amount of embarrassment to the thoracic contents. A few cases have been reported in which the patient exhibited typical ulcer symptoms, but we are inclined to agree with Truesdale¹³ and others in the belief that such instances are in the minority. For the most part, the ulcer has been unsuspected, being found only at operation or autopsy. In a number of instances autopsy revealed an ulcer of considerable size which had been overlooked even at operation. One finding which has impressed us strongly, however, both from our own cases and from a review of the cases reported by others, is that clinical indication of gastrointestinal hemorrhage is almost invariably present. This may be in the manner of frank hemorrhage, which, according to

Harrington,⁵ is usually indicative of severe incarceration of the stomach, or as tarry stools, occult blood in the stool, or secondary anemia.

In our own series of 6 cases of ulcer associated with esophageal hernia, demonstrated roentgenologically, the age range was from twenty-eight to sixty-five, with an average of fifty plus. Three of the patients were men and 3 women. In all but one there was a tendency toward obesity. In only one case was the diagnosis made clinically. All but one patient exhibited signs indicative of gastric bleeding. Of our cases of diaphragmatic hernia uncomplicated by ulcer 65 per cent showed some indication of hemorrhage.

We have found roentgenoscopy in both the upright and prone positions advisable, followed by corresponding roentgenographic studies. In the prone position, right anterior oblique views have proved most useful, as the barium is held in the cardia and the esophagus. It was sometimes necessary to lower the head of the table slightly and palpation was occasionally required.

CASE REPORTS

CASE 1. S. F., male, white, aged forty-one, travelling salesman, complained of recurrent epigastric pain over a period of five years. It was irregular in character, was not definitely related to food, but was aggravated by alcohol. Tarry stools had been passed on several occasions. The guaiac test for occult blood was 4 plus. A borderline anemia was present.

Roentgenography revealed a diaphragmatic hernia, with the antrum and cap in the thoracic cavity. The cap was deformed, and on the lesser curvature at the point of narrowing, where the stomach passed through the opening of the diaphragm, was an ulcer (Fig. 1). A phrenic crushing was performed on the left and the hernia was repaired. The stomach was not opened at the time of operation. A postoperative roentgen study showed reduction of the hernia to be almost complete, with only a suggestion of a small pocket projecting through the hiatal opening (Fig. 2). The ulcer crater on the lesser curvature side of the stomach was still demonstrable roentgenoscopically and on the

films. The patient later was transferred to a Veterans Hospital and the case could not be followed further.

CASE II. A. A., female, white, married, aged twenty-eight, had suffered from cardiospasm since the age of fourteen. Roentgenograms showed this to be rather advanced, with marked dilatation of the esophagus (Fig. 3).



FIG. 1. Case I. Diaphragmatic hernia with antrum and cap in the thoracic cavity. Deformed cap and gastric ulcer on lesser curvature of the stomach at the hiatus.

The condition was corrected surgically at the age of thirty. Six months later the patient complained of pain in the lower portion of the chest, which was aggravated by meals. She gave a history of coffee-ground vomitus and tarry stools on several occasions. Laboratory reports showed a 4 plus guaiac reaction in the stool and a severe secondary anemia, with hemoglobin of 3.4 gm. Roentgenographically a portion of the stomach appeared to be pulled up through the esophageal hiatus and an ulcerative lesion was demonstrable at the esophageal orifice where the upper end of the stomach passed through (Fig. 4). On esophagoscopy a small ulcer was seen a few centimeters above the stomach, in the esophagus. The patient later moved from the city and contact with her was lost.



FIG. 2. Case I. Postoperative roentgenogram with practically complete reduction of the hernia. The ulcer crater on lesser curvature side of the stomach still visible.



FIG. 3. Case II. Advanced degree of cardiospasm with marked dilatation of the esophagus.



FIG. 4. Case II. Postoperative roentgenogram; a portion of the stomach appeared to be pulled up through the esophageal hiatus with an ulcerative lesion at the esophageal orifice.

CASE III. M. S., male, aged sixty-two, had an esophageal hiatus hernia diagnosed a year previous to the onset of epigastric distress. At the time of roentgen examination there was not a definite history of ulcer, and there were no clinical findings indicative of gastrointestinal bleeding. A large hiatal hernia with an ulcer pocket on the lesser curvature side of the stomach, near the point of its herniation through the diaphragm, was visualized roentgenographically and roentgenoscopically. The patient responded well to medical management but unfortunately progress roentgenograms were not obtained.

CASE IV. P. B., white widow, aged sixty-five, was suspected clinically of having metastatic carcinoma of the lower bowel. The guaiac test of the stool was 4 plus upon several occasions. Roentgenographically a large hiatal hernia was seen, with most of the stomach in the chest cavity and an ulcer at the point of narrowing (Fig. 5). A second examination showed the same picture. A year later the ulcer was no longer

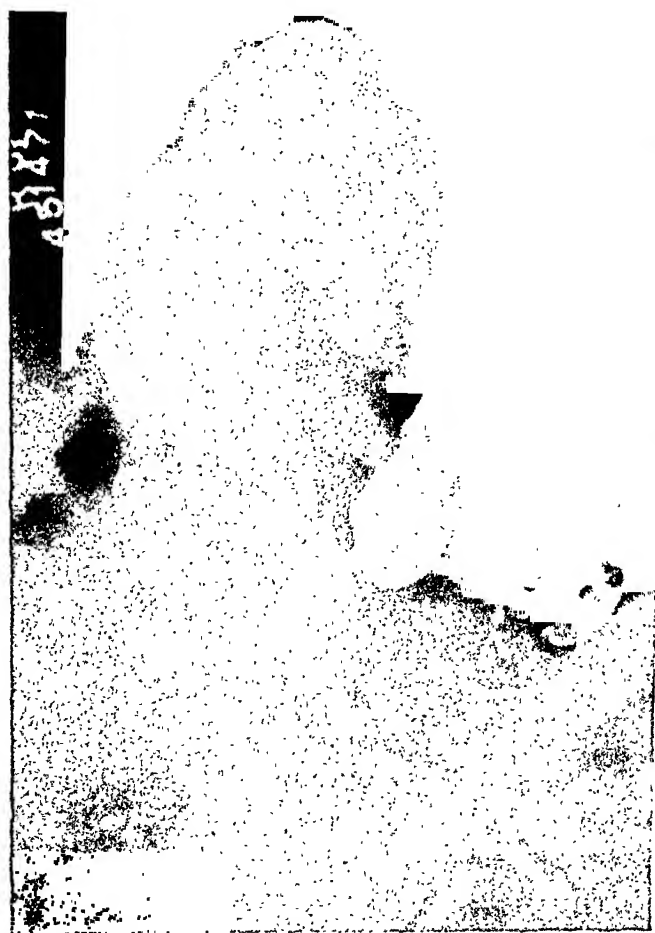


FIG. 5. Case IV. Large hiatal hernia with most of the stomach in the chest cavity and an ulcer at the point of narrowing.



FIG. 6. Case IV. At examination a year later the ulcer was no longer demonstrable but the hernia was still present.

FIG. 8. Case vi. Diaphragmatic hernia with a diverticulum in the cardiac end of the stomach as well as an ulcer at the hiatal opening.

demonstrable but the hernia was still present (Fig. 6).

CASE V. W. S., white male, aged sixty-four, a retired lumberman, had a previous diagnosis of diaphragmatic hernia. On clinical examination, the impression was diaphragmatic hernia with ulcer. The laboratory findings showed a severe secondary anemia. Roentgenographically a hiatal hernia was demonstrated, with a large ulcer pocket on the lesser curvature side of the stomach, just above the diaphragm opening (Fig. 7). Myocardial failure ensued and at autopsy the ulcer was found to have penetrated the stomach wall and to be walled off by peripancreatic fat.

CASE VI. I. P., housewife, aged fifty, gave a five year history of dull epigastric distress which had gradually become worse, with episodes of pain associated with nausea and vomiting. On two occasions there was coffee-ground vomitus and the stool gave a 4 plus guaiac reaction. On three different occasions roentgenograms revealed a diaphragmatic hernia with what we believe to be a diverticulum in the cardiac end of the stomach, as well as an ulcer at the hiatal opening where the herniation occurred (Fig. 8). The patient was placed on strict medical management. Subsequent ex-

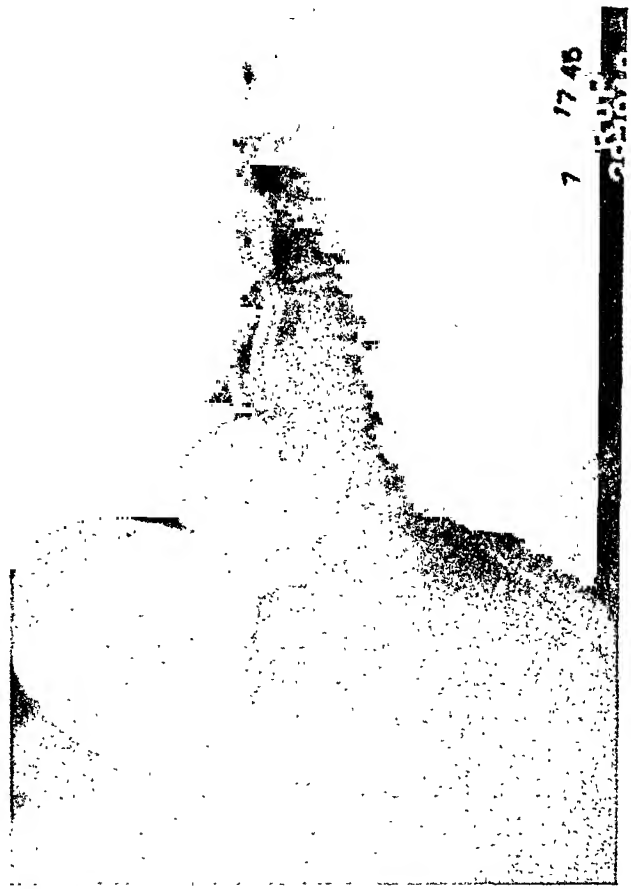


FIG. 7. Case v. Hiatal hernia with large ulcer pocket on the lesser curvature side of the stomach just above the diaphragm opening.

FIG. 9. Case vi. After medical management subsequent examination again showed the diverticulum but the ulcer pocket was no longer demonstrable.

amination again showed the diverticulum but the ulcer pocket was no longer demonstrable either roentgenoscopically or on the roentgenogram (Fig. 9).

SUMMARY

The subject of diaphragmatic hernia has been briefly reviewed and the problem of ulceration occurring in connection with hiatal hernia and the congenital short esophagus with thoracic stomach has been discussed. Inclusion of the short esophagus with thoracic stomach as a subdivision of hiatal hernia is justified on embryologic grounds.

Twenty-two cases of gastric ulcer associated with hiatal hernia were collected from the literature and six new cases are reported. Such ulcers are attributed primarily to the constricting action of the hiatal orifice.

Thirty-eight cases of esophageal ulcer in patients with congenital short esophagus and thoracic stomach were discovered in the literature. Regurgitation of the acid gastric juice and its eroding action on the stratified squamous epithelium of the esophagus are believed to be the responsible factors in these cases.

It is probable that the occurrence of ulceration in conjunction with diaphragmatic hernia is more frequent than has been realized. Clinical symptoms of ulcer are often absent, though in practically all cases there has been some evidence of gastrointestinal bleeding. It is probable, however, that some of these cases are being missed roentgenographically, as a number of them have been discovered primarily at operation or at the postmortem examination. A careful roentgenologic study should be made for ulcer craters, especially in the narrowed area of the stomach where it passes through the esophageal hiatus.

Henry Ford Hospital
Detroit 2, Mich.

REFERENCES

1. ÅKERLUND, Å., ÖHNELL, H., and KEY, E. Hernia diaphragmatica hiatus oesophagei. *Acta radiol.*, 1926, 6, 3-68.

2. COLLIER, W., HURST, A. F., and SHEAF, E. W. Two cases of gastric ulcer associated with congenital diaphragmatic hernia. *Guy's Hosp. Rep.*, 1929, 79, 159-172.
3. DICK, R. C. S., and HURST, A. Chronic peptic ulcer of the oesophagus and its association with congenitally short oesophagus and diaphragmatic hernia. *Quart. J. Med.*, 1942, 11, 105-120.
4. FRANK, L. W., and HAMILTON, J. E. Diaphragmatic hernia with penetrating ulcer of herniated stomach. *J. Thoracic Surg.*, 1941, 11, 219-226.
5. HARRINGTON, S. W. Diaphragmatic hernia associated with traumatic gastric erosion and ulcer. *Surg., Gynec. & Obst.*, 1930, 51, 504-521.
6. HARRINGTON, S. W., and KIRKLIN, B. R. Clinical and roentgenological manifestations and surgical treatment of diaphragmatic hernia, with a review of 131 cases. *Radiology*, 1938, 30, 147-156.
7. HUME, J. B. Congenital diaphragmatic hernia. *Brit. J. Surg.*, 1922, 10, 207-215.
8. JACKSON, C. Peptic ulcer of the esophagus. *J.A.M.A.*, 1929, 92, 369-372.
9. RUDE, J. C. Healed gastric ulcer with associated inflammatory fibrotic changes in a diaphragmatic hernia. *Radiology*, 1942, 38, 729-732.
10. SANGSTER, A. H. Left diaphragmatic hernia; perforation of gastric ulcer into left pleural cavity. *Brit. J. Surg.*, 1936, 23, 638-685.
11. SHANKS, S. C. Hiatus hernia. *Brit. J. Radiol.*, 1948, 21, 55-66.
12. STEINER, G. Chronic ulcerative oesophagitis with report of a case of ulcer in oesophageal varices. *Brit. J. Radiol.*, 1946, 19, 145-152.
13. TRUESDALE, P. E. Gastric ulcer associated with diaphragmatic hernia. *New England J. Med.*, 1932, 207, 385-390.

DISCUSSION

DR. ROSS GOLDEN, New York, N. Y. Drs. Miller and Doub have given an excellent review of ulcer in hiatus hernia. Bleeding from the mucosal surface of the herniated portion of the stomach can occur without peptic ulceration, but it seems probable that some small craters may be hidden among the enlarged mucosal folds. They mentioned the right prone position. In my experience, this is the best position for detecting small hiatus hernias, and is better than the supine Trendelenburg position with manual pressure on the epigastrium. This is probably due to the increased intra-abdominal pressure produced by the weight of the body on the abdomen.

RELATIVE INCIDENCE OF BONE LESIONS OVER A THIRTY-SEVEN YEAR PERIOD*

By SHERWOOD MOORE, M.D.

ST. LOUIS, MISSOURI

THE changing picture of disease has not engaged the attention of the medical profession as widely as is merited. The pattern is never static but subject to endless changes from country to country and in different sections of the same country.

The devastating world-wide epidemics of the past happily seem to have disappeared, at least since that of the influenza epidemic during and following World War I. However, if this is the case, we should not be blinded to the possibility of newer, subtler, and more disastrous epidemics in view of the promise of biological or bacteriological warfare threatened in the future.

In the writer's medical school days the curriculum included instruction in the epidemics of cholera, yellow fever, plague, diphtheria, smallpox, meningitis—all of which occurred from time to time in this country. The older surgeons could recount experiences of what was known to them as "hospital gangrene," which would empty a hospital ward overnight. Other diseases of this type but of lesser proportion have had a decreasing incidence; for example, typhoid fever and diphtheria. Malaria, formerly a scourge in the Mississippi Valley, is now, fortunately, almost nonexistent except in rural areas; however, poliomyelitis is much more widespread, and neither tularemia nor Rocky Mountain spotted fever is confined to the locality of its origin.

Dermatophytosis, introduced into the United States following the Spanish-American War, is widespread, and though its dangers are few, if any, it causes great discomfort and is a nuisance, especially to radiotherapists. Future developments alone will tell what payment for diseases intro-

duced into this country will be made as an aftermath of World War II.

How and in what manner do these general considerations concern radiological practice? Radiologists must have been aware for a long time of the diminishing number of particular diseases or conditions they encounter which were formerly commonplace. Having this in mind, it is believed that it is time to take stock of what has been done in the past in the radiological field. Having this in mind, it was believed that an analysis of the diseases and injuries in which roentgenography has proved its use over a long period would be useful, interesting, and of practical value.

The skeleton was chosen for this purpose, as it was the anatomical system in which roentgenology first established its worth and had earlier attained a higher degree of value than in the respiratory, gastrointestinal, or genitourinary systems.

How recently has any reader seen a tabetic gait in public? How often has he been requested to treat tuberculous lymphatic nodes with roentgen rays? How often does he see a spina ventosa or a saber shin? How has the use of the sulfa drugs and their later successors influenced his opinion in films of the paranasal sinuses, mastoids, and suspected osteomyelitis? Lobar pneumonia and post-pneumonic empyema are happily rarely found. It is hoped that an analysis of this large material (Fig. 1) of bone conditions will show the following: the vast increase in the proficiency of the roentgenologist; the advance in technique and apparatus; an increased resort to roentgen examinations in disease and injuries to the skeleton, and metabolic diseases which affect the skeleton.

* From the Edward Mallinckrodt Institute of Radiology of the Washington University School of Medicine, St. Louis, Missouri. Presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

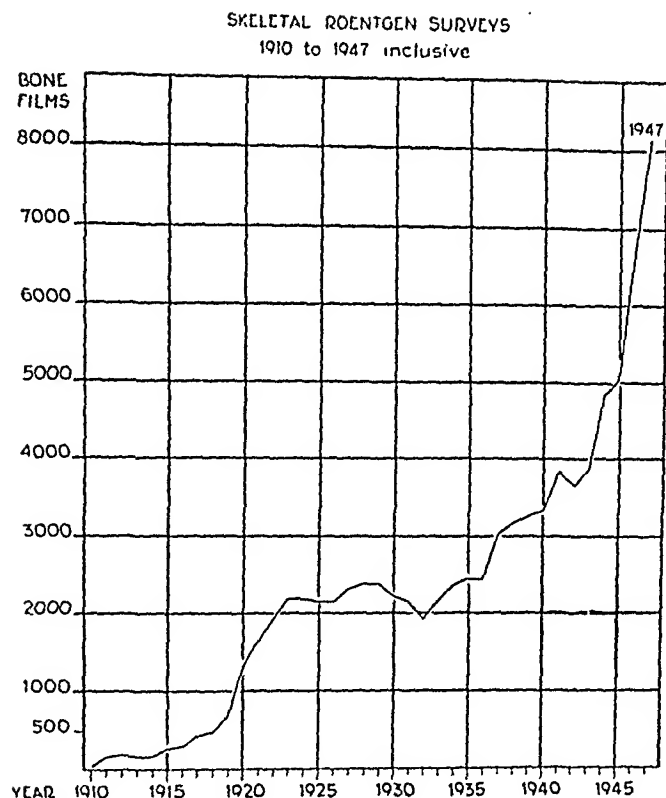


FIG. 1

- × RICKETS AND RACHITIC DEFORMITIES
- SCURVY

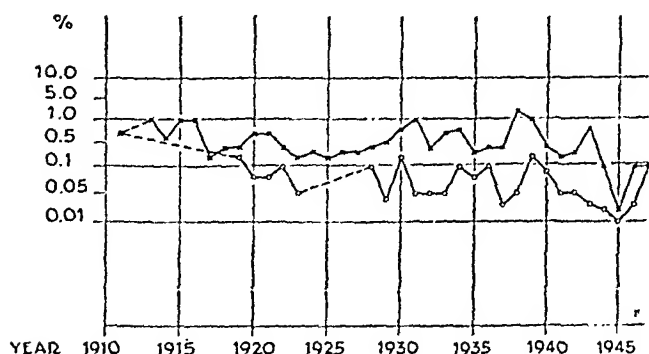


FIG. 2

- × OSTEOMYELITIS
- SYPHILIS OF BONE
- + TUBERCULOSIS OF BONE

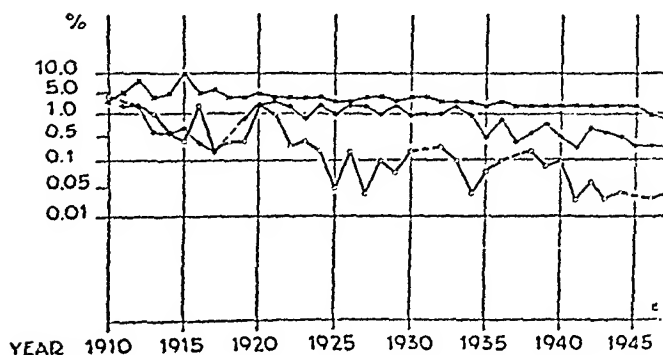


FIG. 3

In advance of collecting the data for this paper, there was a hope that the analysis would show a decreasing incidence of the worst types of disease of the skeleton (Fig. 2 and 3). It was also expected that fractures would show a change over the years traceable to the automobile, industrial accidents, etc. It will be seen later that this has not been entirely the case; while some of the worst diseases have lessened, others, such as metastatic carcinoma, have shown a rapid increase especially in the last few years.

Few readers have any knowledge of the limitations of equipment and roentgen-ray tubes at the early period at which these records begin. For this, the roentgenologist should be thankful. For example, satisfactory roentgen examination of the lumbar spine in the lateral projection was a brilliant (and accidental) achievement until Hollis Potter devised his diaphragm, which was not too long ago.

Undoubtedly, the 29 bone cases roentgenographed in 1910 represented a very active interest in and dependence on this type of examination. The percentage for the year 1947 will be given later. It should be of interest to roentgenologists that the x-ray department of the old Washington University Hospital was organized by the late Russell D. Carman.

The roentgen-ray records from 1910 to 1947, inclusive, are a composite representation of the opinions of many junior men, past and present. The many errors of inclusion should offset the number of errors of omission, since the number of cases included in this study is so large. I assume that I probably made more errors than any of the others in making these reports; in any event, the mistakes are mine.

Of the 87,899 individuals with examination of part or all of the skeleton, 55,245 were negative and 32,654 had a pathological condition of one kind or another. Naturally, some of the former were pathological and probably more of the pathological were normal or negative. Of the pathological cases the majority, as one would anticipate,

were fractures—21,677 (Fig. 4), and this includes both traumatic and pathological fractures even though the hospitals of the Washington University Medical Center have little traumatic surgery and the group includes such special hospitals as the St. Louis Maternity Hospital, where a fracture would be a rare occurrence.

The rarer diseases of bone were so few in number that they were not included in the percentages calculated by years. There were 24 cases of leontiasis ossea in the last thirty years; 8 cases of osteopetrosis in the last twenty-seven years, and over the same period, 18 cases of osteopsathyrosis; there were 2 examples of odontoma in twenty-five years; Kummell's disease or deformity was seen 3 times in twenty years; osteopoicelia, 3 times in twenty-one years; sporotrichosis of bone, 4 times in the last eighteen years; 21 examples of xanthoma of bone in seventeen years; 15 adamantinomas in fifteen years; ivory vertebrae were observed 5 times in thirteen years; melorheostosis, 7 times in five years; symmetrical thinning of the parietal bone found twice in the last three years.

The reports on roentgenograms of the skull were intentionally omitted, as was meningioma, although fracture and osteomyelitis of the bones of the skull are included.

There were 164 cases of osteitis deformans including osteoporosis circumscripta (Fig. 5). There were 30 examples of osteitis fibrosa cystica. There were 73 cases of giant cell tumor which are not distributed by years. The joints have been omitted except neurogenic arthropathy and tuberculosis of the spine. Diaphyseal tuberculosis is rare, and in this material was found only in phalanges except in one case. Neurogenic arthropathy, naturally, comes under the heading of syphilis, though not included in the graph showing that disease (Fig. 6); and it, too, in the view of the writer, is chiefly but not entirely a disorder of bone, joint involvement being secondary, as is the case with tuberculous joints.

There is a large group of bone tumors in

FRACTURES, AVULSIONS AND SEPARATIONS OF EPIDYSPHYSIS

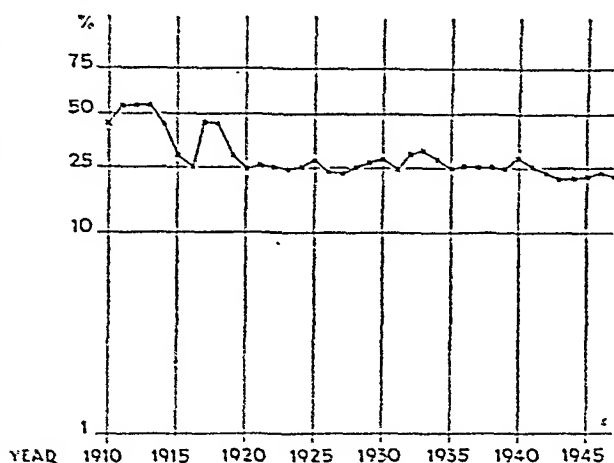


FIG. 4

OSTEITIS DEFORMANS

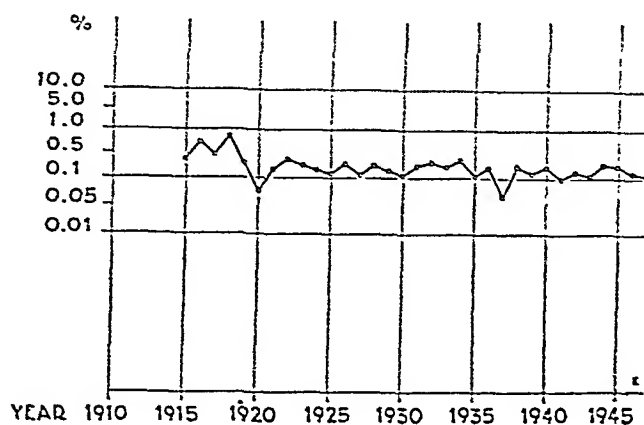


FIG. 5

NEUROGENIC ARTHROPATHY

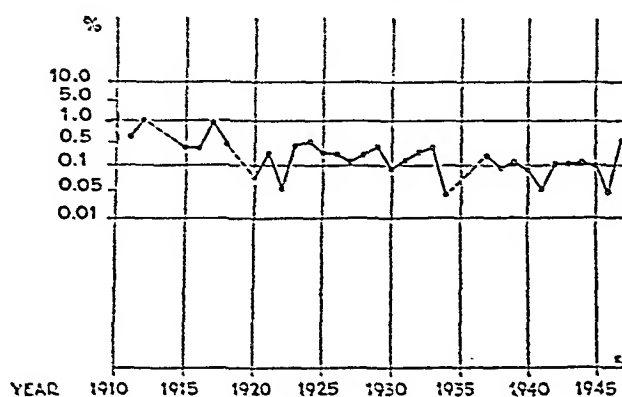


FIG. 6

which the records did not state the type of tumor (Fig. 7). Among them were a number of metastatic tumors. In my opinion, metastatic tumors of the skeleton are prac-

tically exclusively of epithelial origin. The changing terminology applied to sarcoma of bone in the past four decades leaves recognition of this neoplasm still somewhat confused in the records. For the past two decades bone sarcoma has meant osteogenic

There is a large number of reports of osteitis and periostitis with the type not given. In fact, they eluded more specific designation. The same is true of the number of cases of erosion of bone where the cause was not given—the cause not being stated because it could not be stated.

A digression is in order to point out that roentgenologic interpretation or opinion or report, whichever term one chooses to use, is, after all, but a memorandum opinion, and it is a lamentable fact that the radiologist gets confirmation or refutation of the opinion which he has expressed only with the greatest difficulty; indeed, the refutation is many times easier to secure than confirmation. The late Dr. R. W. Mills once put it this way: "It takes five minutes for a doctor to tell you that your x-ray diagnosis is wrong, and it takes three weeks of patient endeavor to find out if you were right."

In the calendar year 1947 there were 35,747 diagnostic roentgen examinations recorded here. The number of admissions to the hospitals of the Washington University Medical Center were 41,266. The figure for the number of roentgen examinations made on these hospital admissions is not available, but there were 9,850 ambulatory private patients who needed roentgen examinations. Of the total 35,747 roentgen examinations for the year, 8,110 were of the skeleton. This constitutes 22.4 per cent of the diagnostic procedures for the year.

SUMMARY

The records of the cross-filing of roentgenograms from the years 1910 to 1947, inclusive, have been key-punched. By using the sorter, the records of 87,899 individuals, who had a skeletal examination in whole or part, were analyzed. Of the 32,654 with a pathological report, several interesting things were discovered; the most striking being the great increase in the roentgen examinations of the skeleton. Advances in roentgenological knowledge and practice are shown by the relatively recent record-

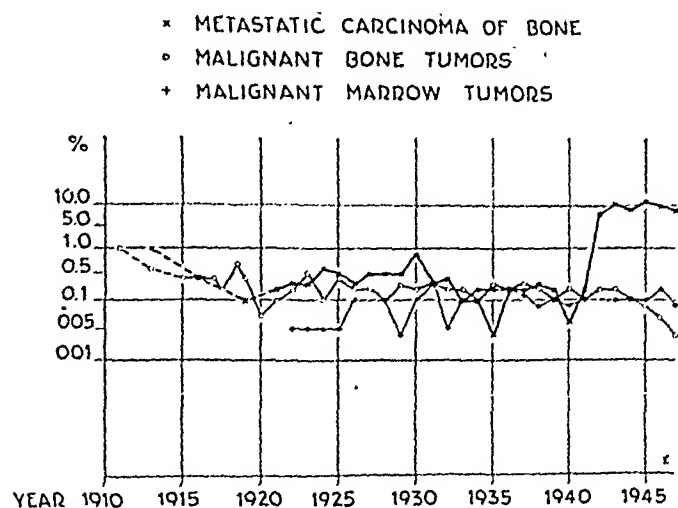


FIG. 7

sarcoma. The malignant diseases of the bone marrow are grouped together as myeloma, including the endothelial myeloma of Ewing (Fig. 8).

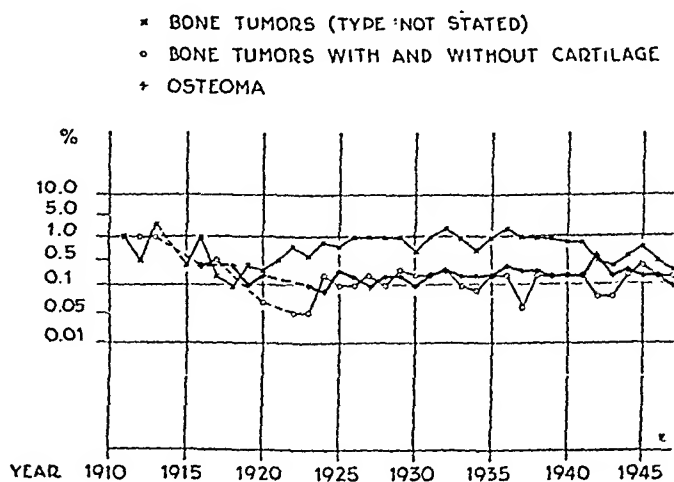


FIG. 8

That some of the cases of myeloma were actually sarcomas and that some of the sarcomas were myelomas is beyond question; but the greatest error would be found in mistaking myeloma for metastatic carcinoma of bone, or vice versa. However, the number is large enough that here, again, errors should cancel each other out.

ing of the rarer diseases of bone. There is a marked decline in the incidence of syphilis and an almost equal decline in that of osteomyelitis. Bone tuberculosis has maintained a quite constant level since the year 1920. In traumatic conditions there was a marked decline in percentage in 1920 and since that year the curve has remained flat. Rickets and scurvy have shown a considerable decline with some upward peaks. Osteitis deformans and neurogenic arthropathy have a fairly constant percentage. Malignant bone marrow tumors were not recorded before 1922 and since 1926 have remained of fairly constant occurrence. There is a tremendous rise in metastatic

carcinoma of bone since 1940; this could be accounted for by the more extensive investigations of patients with carcinoma and perhaps the greater longevity of such patients. At present metastatic carcinoma stands next to fractures in incidence. Malignant bone tumors are fairly constant. The relative incidence of bone lesions will vary according to the type of hospital. All in all, the analysis, though it contains many errors, nevertheless should be of interest to roentgenologists.*

510 S. Kingshighway Blvd.
St. Louis 10, Mo.

* For discussion, see page 386.



THE ROENTGENOLOGIC EXAMINATION OF THE CERVICAL SPINE*

By JOSEPH C. BELL, M.D., and JAMES B. DOUGLAS, M.D.

LOUISVILLE, KENTUCKY

PAIN in the cervical area, the shoulder and arm has long constituted a major diagnostic and therapeutic problem. Knowledge of the causes of such pain has increased rapidly in recent years and definitive therapy, surgical or otherwise, has progressed. The causes of cervical and shoulder pain, as we all well know, are



FIG. 1. Standard position No. 1. Lateral view of cervical spine. Normal.

many. In some instances the pain is due to a lesion of the cord itself but these are uncommon. Much more frequent are lesions adjacent to the cervical cord with impingement upon the cord or the nerves leaving the cord. The latter are of many types, relatively common ones being rupture of the annulus fibrosus with extrusion of a

portion of the affected disc into the spinal canal, hypertrophic arthritic changes that encroach upon the lateral foramina; primary and metastatic tumors and various traumatic lesions.

The basic projections employed in our work are all standard and in no way original with us. Some such method of examination is employed by nearly all experienced roentgenologists but an outline of the plan of investigation we have found reliable and relatively simple may be of some value to the young roentgenologist who by trial and error or lack of knowledge of the methods of others has not as yet adopted a satisfactory procedure.

Position No. 1. (Fig. 1) The lateral projection. When possible the patient should be sitting or standing but when this is not feasible almost equally satisfactory roentgenograms can be secured with the patient supine, lying on a litter, the central ray being parallel to the top. A stationary grid is employed, the one described by Camp, with the grid a part of the cassette being used in our work but any other stationary one is satisfactory. The film size should be 10 by 12 inches. The lower margin of the cassette is placed approximately 1 inch below the level of the acromium and the roentgen-ray beam is centered at the level of the body of the fifth cervical vertebra. A 6 foot tube-film focal distance is employed. The neck is held in a neutral position and the patient required to fix her eyes on a point directly in front of her, respiration being suspended during the exposure. Films are made in flexion and extension when indicated but in our opinion do not yield sufficient additional information to justify their inclusion as a part of the basic examination.

* Presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

Position No. 2. (Fig. 2) Direct anteroposterior projection. An 8 by 10 inch film usually includes the upper two or three dorsal vertebrae, the surrounding area and all of the cervical spine with the usual exception of the first and second vertebrae. It is of value in detecting cervical ribs, lesions in the pulmonary apices such as primary bronchogenic carcinomas, subclavian aneurysms, substernal extensions of the thyroid and destructive lesions involving the lateral processes, many of which cause shoulder and arm pain.

Position No. 3. (Fig. 3) This projection is of the first and second cervical vertebrae made through the open mouth, the centering being immediately below a line that passes from the lower margins of the upper central incisors to the base of the mastoid. It is of particular value in demonstrating fractures of the odontoid, fractures of the arches of the first cervical vertebra and dislocations.



FIG. 2. Position No. 2. Direct anteroposterior view of cervical and upper dorsal spine. Cervical spine normal. Hemangioma of third dorsal vertebral body.

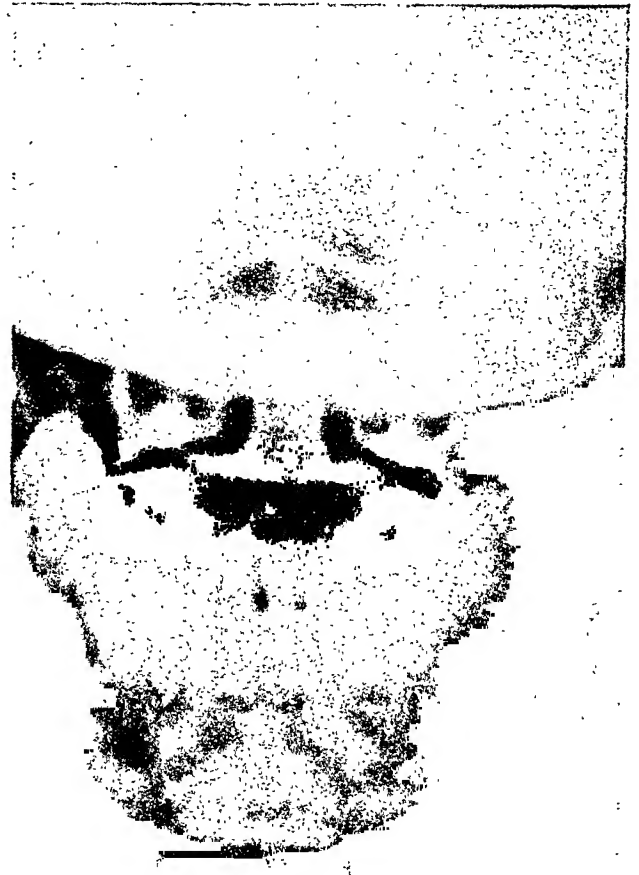


FIG. 3. Position No. 3. Visualization of first and second cervical vertebrae through open mouth. Normal.

Positions No. 4 and 5. (Fig. 4 and 5) These positions are the right and left posteroanterior oblique projections. They are of major value in demonstrating the lateral foramina, the lateral articulating processes, in demonstrating degenerative arthritic changes and in revealing hypertrophic deposits which may encroach upon the foramina and may, or may not, impinge upon the nerves passing through those in question. They are of value also in demonstrating many traumatic and other destructive lesions. In all instances where the normal anterior cervical curve is present the exposures are made with the patient prone, the head being placed in a true lateral position and the shoulder elevated so that the plane of the shoulders is at approximately 45 degrees to the horizontal. The centering is over the fourth cervical vertebra, the central beam being perpendicular to the film. The tube may be

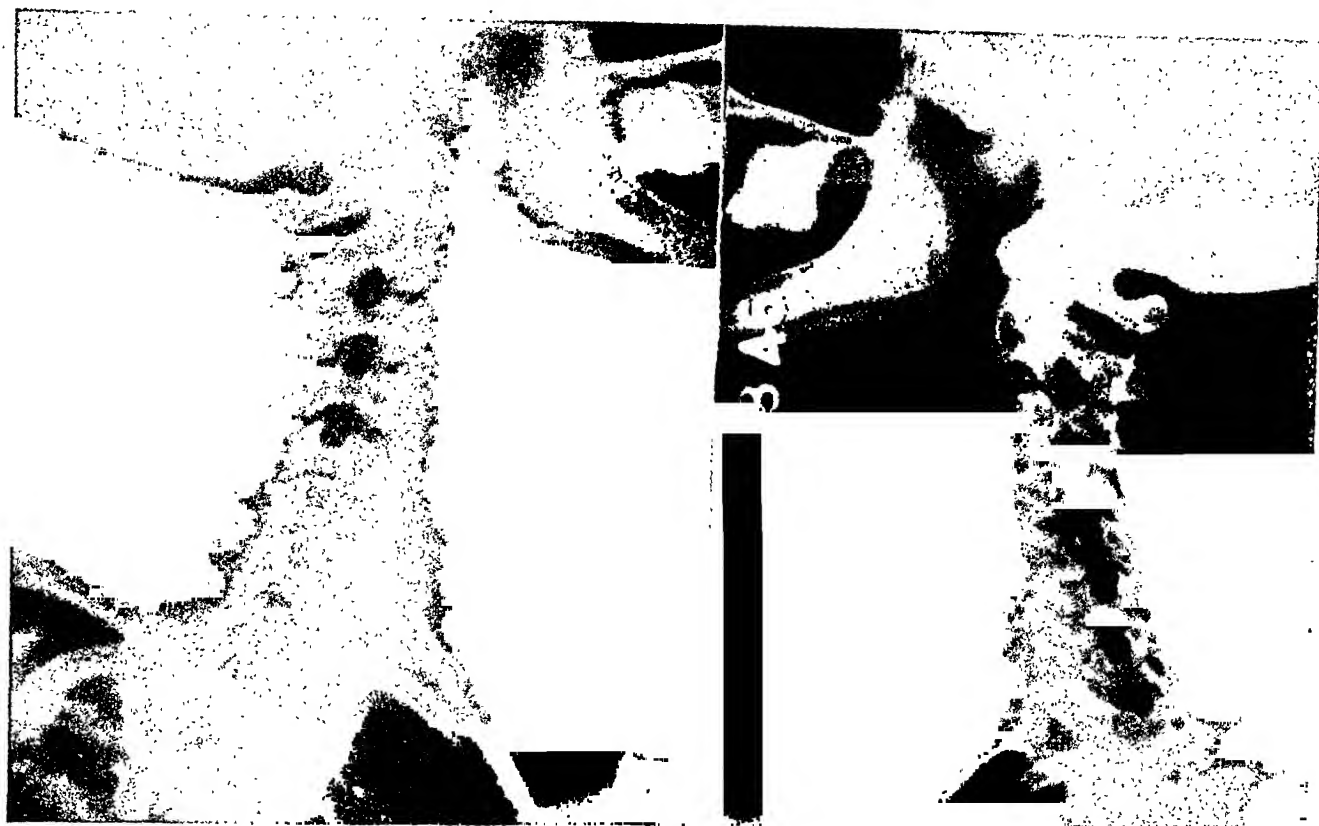


FIG. 4. Positions No. 4 and 5. Right and left posteroanterior oblique projections of cervical spine. Lateral foramina well shown. Normal. Lateral articulating processes also well demonstrated.

angulated somewhat toward the feet in individuals with large shoulders when the long axis of the cervical spine is not approx-

imately parallel to the table top. In the presence of marked muscle spasm the anterior cervical curve may be absent and a reversal of the normal curvature present. In such instances the oblique projections are best made in the anteroposterior oblique positions rather than the posteroanterior as is usually true.

These are the five basic positions employed. We consider stereoscopic views unnecessary except in special instances indicated by the preliminary findings.

RUPTURE OF THE CERVICAL INTERVERTEBRAL DISC

Rupture of the annulus fibrosus with extrusion of a portion of the intervertebral disc into the spinal canal in the cervical region is now recognized as a relatively common clinical entity.

William B. Scoville of Hartford, Connecticut, at the meeting of the Harvey Cushing Society in San Francisco, August 20, 1948, reported an analysis of 68 operated cases, 22 of which had previously been reported, 12 by Spurling and Scoville and



FIG. 5. Position No. 1. Lateral exposure of cervical spine. Fracture of dens with anterior displacement of dens and first cervical vertebra. Anterior dislocation of body of fifth cervical vertebra in relationship to sixth with fractures of posterior processes.

to by Whitcomb. The average age at the time of operation was forty-three years, the youngest being in the twenties and the oldest being in the fifties. There was a definite history of trauma in 50 per cent of the cases. The duration of symptoms was less than one year in 75 per cent of the reported cases and less than three months in 50 per cent. Pain was a symptom in all but one, numbness was present in 50 per cent and the spinal fluid protein was above 40 mg. per cent in 30 per cent of the cases and over 50 mg. in 20 per cent. In 42 cases analyzed in regard to the level of the herniation, 12 were found at the level of the fifth cervical interspace, 28 at the sixth and 2 at the seventh, the latter being the interspace between the bodies of the seventh cervical and first dorsal vertebrae. In 80 per cent the extruded material was soft in character and in 20 per cent hard, at times being partially calcified. Large defects were less common than small ones, those involving only the adjacent root sleeves. In 60 per cent of the cases localized proliferative arthritic changes were



FIG. 6. Position No. 3. Fracture of dens with moderate angulation toward the right shown through open mouth.

demonstrated in preliminary roentgenograms.

Surgeons found quite early that some individuals having symptoms thought to be due to rupture of a cervical intervertebral disc showed no evidence of extrusion of any part of the intervertebral disc into

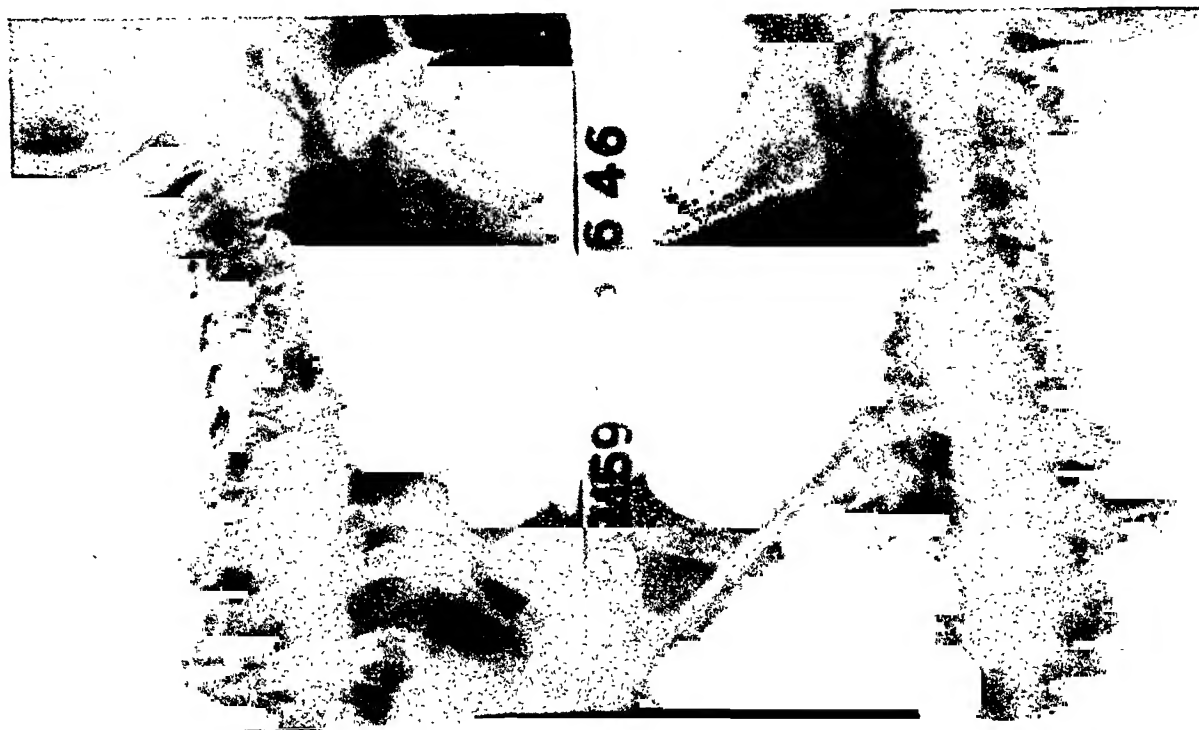


FIG. 7. Positions No. 4 and 5. Posteroanterior oblique views of cervical spine showing marked hypertrophic changes encroaching upon foramina between fifth and sixth and sixth and seventh cervical vertebrae on both sides.



FIG. 8. Cervical myelography. Normal.
Axillary pouches well shown.

the spinal canal but instead showed hypertrophic changes that encroached upon a lateral foramen and in some instances quite obviously impinged upon the nerve passing through the foramen. It is because of the above and the many other cervical lesions that may produce symptoms simulating the presence of a so-called herniated nucleus pulposus that a very careful and complete roentgen examination of the cervical spine is essential.

CERVICAL MYELOGRAPHY

Some neurologic surgeons believe the neurologic findings and history sufficiently

definite, in many lesions of the cervical spine, to justify operation without myelography. Others continue to employ cervical myelography even in many instances where the clinical and neurologic findings are considered diagnostic.

After hearing the presentations and discussions at the Harvey Cushing Society in San Francisco, it is the impression of one of us (J.C.B.) that there now is a definite trend toward more frequent use of myelography in both the cervical and lumbar examinations, although during the previous



FIG. 9. Cervical myelography. Relatively large defect indicated by arrow at level of fifth cervical interspace at operation shown to be due to lateral rupture of annulus fibrosus with extrusion of a portion of the disc into the spinal canal.

two or three years the trend was in the opposite direction.

In our practice cervical myelography is always done in conjunction with a neurosurgeon and is always preceded by the above described standard roentgen examination of the cervical spine. Pantopaque is the contrast medium employed and much more accurate information is obtained when 6 cc. is injected instead of 3 cc. commonly used in myelography in the lumbar area. The patient is placed prone on the roentgenoscopic table, the head being at what is ordinarily the foot area in the event that a special two-way tilting table is not available. The latter is certainly in no way essential. The injection, in our examinations, is done by an experienced neurologic surgeon but in some other places may be



FIG. 10. Cervical myelography. Lateral defect indicated by arrow shown at operation to be the result of rupture of the corresponding intervertebral disc. Lesion at sixth cervical interspace.



FIG. 11. Cervical myelography. Very small defect with obliteration of axillary pouch at sixth cervical interspace indicated by arrow. At operation shown to be due to rupture of the intervertebral disc. The defect is small but very characteristic.

done by an orthopedic surgeon or possibly some other physician especially trained in this particular work. Myelography, whether in the cervical or lumbar spine, however, should never be performed by one not thoroughly trained in the technique of the examination nor by one untrained in the neurologic manifestations of encroaching lesions in the spinal area.

When the contrast material is passing from the lumbar region into the cervical area the chin should be elevated and the neck extended to the maximum degree, a position initiated by Spurling and Hampton

at the Walter Reed General Hospital during World War II. We have found it advisable to place the responsibility for the maintenance of the position on the one doing the injection.

After injecting the contrast material the table is tilted lowering the head and elevating the pelvis until the head of the column passes the point of greatest convexity in the dorsal region after which the patient is rapidly returned to the horizontal. From this point onward cervical myelography is as easily accomplished as is myelography in the lumbar area. The patient can usually be supported with no difficulty during tilting by having an assistant hold the lower extremities but in paralyzed individuals more adequate fixation is needed. Such a support is illustrated in *Radiology*, 1944, vol. 43, page 437. It was designed by Frank H. Mayfield, M.D., of Cincinnati, Ohio, and in our hands has proved to be of great value.

In case a complete block is encountered it is wise to elevate the hips and lower the head to a point where there can be no question of the completeness of the obstruction. Complete blocks are relatively easy to demonstrate but are uncommon, partial obstruction being much more frequently seen. Serial exposure, with the column of contrast material at various levels throughout the cervicals and upper dorsal parts of the spinal canal, are always made whether or not defects are noted during the roentgenoscopic phase of the examination. This is essential for many lesions are small, often obliterating only the root sleeves and these rarely can be detected roentgenoscopically but usually are obvious in films. It is our usual practice to make the exposures through a narrow rectangular slit-like opening in the roentgenoscopic shutter using no grid, the exposure being controlled by a quick change-over switch. The films thus secured are of good diagnostic quality but contrast may be somewhat improved by the use of the moving grid in the table and since the column of contrast material can so easily

be controlled there is no reason why this method of exposure is not entirely satisfactory. After the indicated films have been secured, when using the conventional table, it is necessary to reverse the position of the patient so that his head is at the head of the table and his feet rest against the foot support. The table is then tilted usually until the patient is almost vertical or until all of the contrast material returns to the lumbar area. He is then returned to the horizontal, the column of contrast material centered about the needle, the needle having remained in place throughout the examination, after which the pantopaque is removed by aspiration.

CONCLUSIONS

1. An adequate standard method of roentgen examination of the cervical spine is essential. Such an examination should always precede myelography and is indicated in the large percentage of individuals presenting symptoms that might or might not originate in the cervical area.
2. Cervical myelography is neither time consuming nor difficult.
3. Accurate interpretation requires close cooperation between the roentgenologist and the neurologic surgeon or neurologist and demands a painstaking consideration of the history, the neurologic, roentgenologic and laboratory findings.
4. Those with whom we work believe cervical myelography yields information not obtainable by other means amply justifying its employment.

402 Heyburn Bldg.
Louisville 2, Kentucky

DISCUSSION OF PAPERS OF MOORE, AND BELL AND DOUGLAS

DR. MAURICE M. POMERANZ, New York, N. Y. To one whose exclusive interest for the past generation has been orthopedic roentgenology, it is somewhat surprising as well as disappointing to see what casual interest is displayed by the average roentgenologist in this subject. Tangible evidence of this attitude is

the few papers on the program which are devoted to this subject.

Despite the fact that much has been said and a great deal written during the past decade regarding the mechanics and function of the skeletal system, very little is yet known regarding its specific role in many of the diseases which leave their imprint there.

It is for this reason that the studies of Doctors Bell and Moore are timely since they focus attention on a badly neglected field—that of orthopedic roentgenology.

Dr. Bell has divided his paper into three parts: a description of the technique for the examination of the cervical spine, a section dealing with the diagnostic significance of the presence of hypertrophic marginal spurs, and lastly myelography.

While techniques are recommended for the roentgenography of the cervical area, we routinely employ the usual anteroposterior and lateral views and occasionally the oblique views. In our experience these examinations are best performed with the patient in the erect position. We rarely employ the open mouth technique since we have found that the planigram is unexcelled for the demonstration of the first and second cervical vertebrae. Dr. Bell has rightly stressed that the impingement of marginal spurs on spinal foramina may account for some of the symptoms related to this area. This was emphasized almost twenty years ago by Dr. Lewis Gregory Cole. Our experience with cervical myelography has been limited. Curiously enough, however, we have encountered more tumors than herniated discs in this area. It is my feeling that we are too

prone to relate symptoms to slight morphologic or structural changes in the cervical region, forgetting completely the complex soft tissues in this region which must unquestionably be responsible for some of the distress which we see.

I have not had the opportunity to read Dr. Moore's survey but the lantern slides which he has demonstrated yield a great deal of interesting information which cannot be reviewed in the few minutes allotted to me. It is my impression that it is hazardous to attempt to reconcile statistical experiences from one part of the country to another or, for that matter, from one hospital to another. These tables represent a review of what has occurred in a specific hospital in a specific locality. There are so many imponderables. Let me cite one example. If I were to attempt a statistical study of the incidence of congenital syphilis seen by me during the past twenty years at the Hospital for Joint Diseases, I would state that the disease is almost non-existent or at least extremely rare. Yet I am at the moment engaged in a study of 40 patients suffering from congenital syphilis and treated by penicillin at Bellevue Hospital. How would one reconcile these contradictory data for a statistical survey?

The great value of Dr. Moore's paper, to me at least, is the picture it gives of our success in conquering certain diseases. The problem of the increasing incidence of malignant bone tumors is one which we hope the present generation will solve.

It will be very profitable to read these two reports when they are published.



BONE METASTASIS IN MALIGNANT MELANOMA*

By DANIEL WILNER, M.D., and ROBERT L. BRECKENRIDGE, M.D.

PHILADELPHIA, PENNSYLVANIA

THE important feature of malignant melanoma is its metastasis. The primary lesion may be small and insignificant, but its cells can secondarily invade and destroy any tissue including bone. It is the bone involvement, with its roentgen and pathological findings, that has created our interest in reviewing 83 cases of malignant melanoma.

To the best of our knowledge, only isolated articles have appeared in the literature describing the roentgen changes produced by osseous metastasis. One of these was a case described by Livingston⁶ which presented an unusual manifestation of malignant melanoma developing in the lumbar region without evidence of a primary site in the skin or eye. Roentgen examination showed nearly complete destruction of the laminae, transverse and spinous processes of the second and third, with partial destruction of the body of the third, and beginning destruction in the body of the fourth and fifth lumbar vertebrae. Geschickter and Copeland,⁴ in their series, had 3 cases with secondary deposits in bone. The lesions in the long bones were situated about the site of the nutrient

vessels, showing marked destruction and expansion of the bone and some invasion of the soft parts. In one instance, a pathological fracture occurred in the middle third of the humerus. The bone lesions in the 6 cases described by Howes and Birnkrant⁵ were uniformly lytic in character, round or oval in shape, having a clean, smooth edge without evidence of a cortical or periosteal reaction zone. The cortical bone was entirely resorbed within the bone. Only in one case was there an expansile lesion. Here, there was a mushrooming out of the head of the clavicle to about twice its normal diameter and with pathological fracture through its normal shell. Russo⁸ reported 3 cases of malignant melanoma in infancy, 2 of which showed osteolytic lesions in bone. One case revealed symmetrical destructive lesions involving the lateral aspects of the distal metaphyses of both femurs, with little evidence of bone reaction. The second case presented similar areas of destruction in the vertebrae, left sacroiliac joint, both iliac bones and the upper ends of the femurs.

There is considerable variation in the incidence of osseous metastasis as reported by various authors. This incidence is tabulated in Table I.

In our series of 83 cases of malignant melanoma, 9 showed evidence of bone metastasis. Of these, 45 had been studied by roentgen examination, 15 of which had complete bone surveys.

We are presenting 5 of the 9 cases, which show the bone involvement to best advantage.

REPORT OF CASES

CASE 1. A twenty-five year old coal miner was sent to the hospital after a physician had incised an innocent looking tumor of the scalp

TABLE I

Author	Cases	Bone Involvement	Per Cent
Geschickter and Copeland	169	3	1.77
Affleck	317	9	2.84
Howes and Birnkrant	32	6	18.6
de Cholnoky	117	1	0.85
Daland and Holmes	174	12	6.89
Moersch, Love and Kernohan	97	2	2.06
Our series	83	9	10.84
Total	989	42	4.24

* From the Department of Radiology and the Clinical Laboratory of the Jefferson Medical College Hospital, Philadelphia, Pennsylvania.

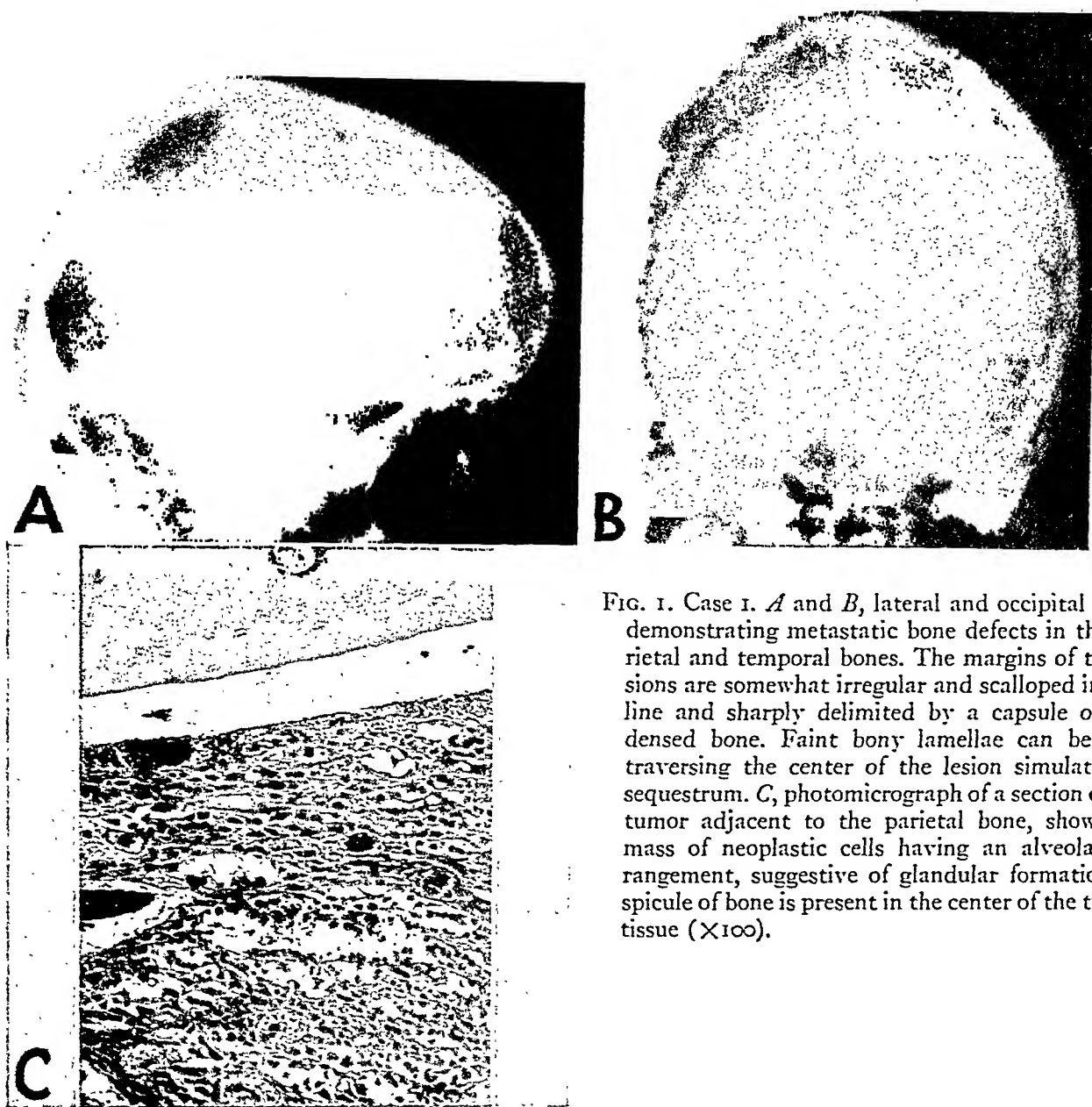


FIG. 1. Case 1. *A* and *B*, lateral and occipital views demonstrating metastatic bone defects in the parietal and temporal bones. The margins of the lesions are somewhat irregular and scalloped in outline and sharply delimited by a capsule of condensed bone. Faint bony lamellae can be seen traversing the center of the lesion simulating a sequestrum. *C*, photomicrograph of a section of the tumor adjacent to the parietal bone, showing a mass of neoplastic cells having an alveolar arrangement, suggestive of glandular formation. A spicule of bone is present in the center of the tumor tissue ($\times 100$).

and discovered, much to his surprise, that it extended into the calvarium. Two years prior to this, the patient had noticed a raised, dark red area below the right scapula, which bled profusely when traumatized, and subsequently he became aware of a mass in the right axilla about the size of a hen's egg. After an interval of one and a half years, the axillary mass began to increase in size and two firm, non-tender nodules appeared on the scalp. At this time he underwent a herniorrhaphy. While convalescing, the scalp nodules became tender, larger, and were accompanied by severe headaches. This was followed by fever, nausea, vomiting, soreness in the chest and pain in the back.

Examination revealed a well developed, well nourished young man with two subcutaneous nodules in the scalp, which were firm and fixed and measured 4 to 6 cm. in diameter. There was an internal strabismus of the left eye and papilledema of both discs of 2-3 diopters. A firm, non-tender, freely movable mass was felt in the right axilla measuring 8 by 4 by 4 cm., and a raised, red tumor, 2 cm. in diameter, surrounded by a margin of scar tissue, was observed 6 cm. below the right scapula. The erythrocyte count was 4.0 to 4.2 million per cu. mm. The sedimentation rate was 30 mm. in one hour. The urine did not contain melanin nor Bence-Jones protein. The glucose tolerance test

showed a diabetic curve. The patient's condition grew rapidly worse and showed signs of cerebral involvement. He died eighteen days after admission.

Roentgenographic examination of the skull disclosed metastatic bone defects which were represented by cyst-like translucencies in the parietal and temporal bones. The margins of the lesions were somewhat irregular and scalloped in outline and sharply delimited by a capsule of

thickness of the scalp and the adjacent bone. The tumors were composed of fleshy, grayish-yellow, solid tissue. The defects in the bone penetrated both tables and were rather jagged in contour. A similar tumor was seen in the subcutaneous tissues of the right axilla measuring 7 cm. in diameter. A slightly raised, oval nodule, measuring 1 cm. in diameter, was present on the right side of the back, at the level of the tenth thoracic vertebra. The peritoneal

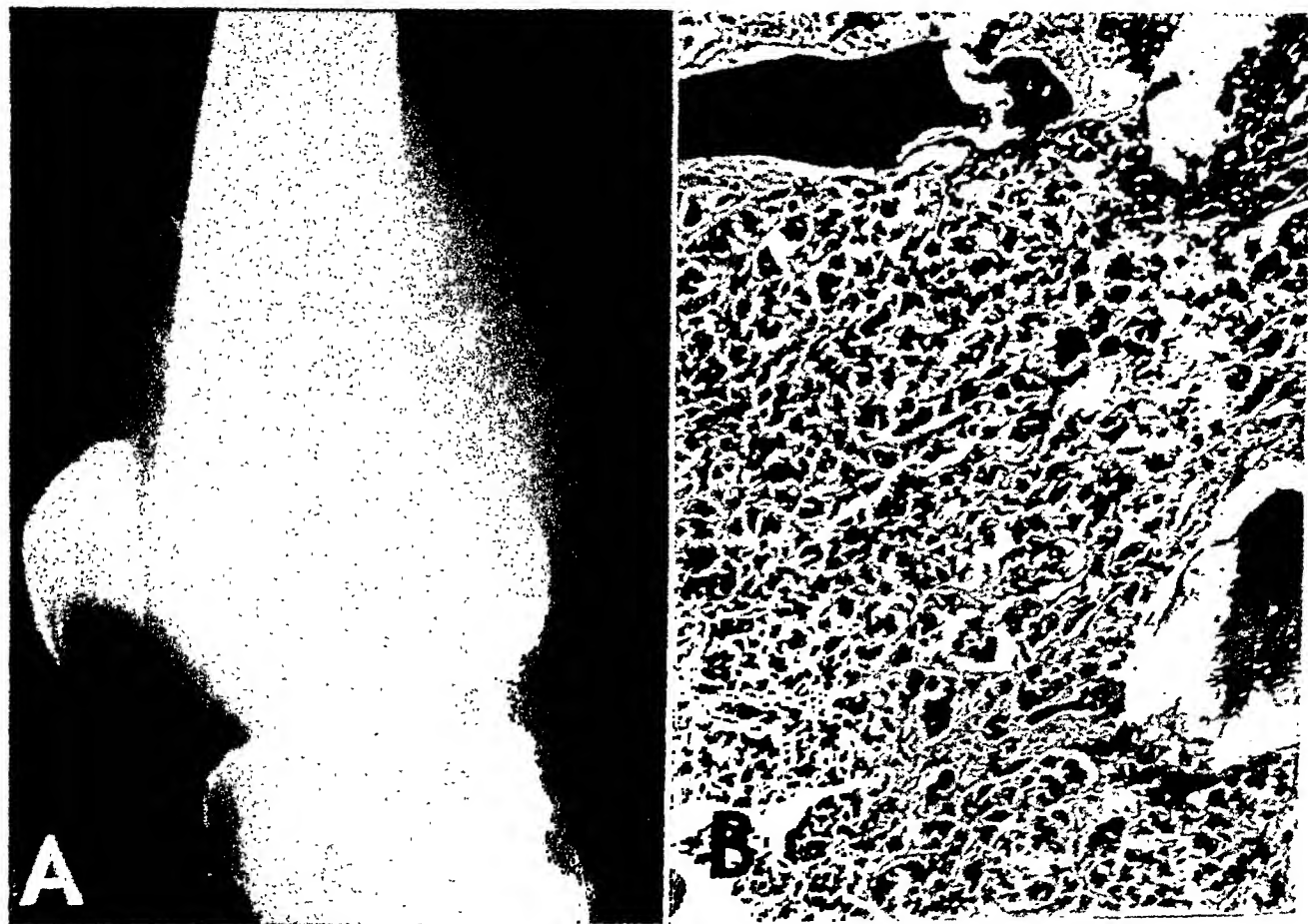


FIG. 2. Case 11. *A*, showing a metastatic process in the distal shaft of the femur. The periosteum and cortex show an interruption in their normal contour and irregular fragments of bone can be seen projecting into a large soft tissue tumor. *B*, photomicrograph reveals several fragments of adult bone surrounded by heavily pigmented neoplastic cells ($\times 100$).

condensed bone. A smaller lesion, however, in the vault of the skull presented an oval cyst-like space with margins which were dense and smooth in configuration. Faint bony lamellae could be seen traversing the center of one of the cranial defects simulating a sequestrum. The remainder of the skeleton was negative for bone metastasis.

Necropsy revealed two firm tumors within the scalp, measuring 6 and 9 cm. respectively, and situated just to the left of the midline in the left temporal region. Both tumors involved the

cavity contained 75 cc. of a turbid, brown fluid. The stomach had four perforations ranging from 0.5 to 2.0 cm. in diameter, which were located on the posterior wall of the fundus. The microscopic diagnosis was malignant melanoma.

CASE 11. A white man, aged sixty-seven, gave a history of having squeezed a pimple on his right cheek about two years before admission to the hospital, and then continued to irritate it while shaving. The lesion never healed completely but instead increased in size. One

month prior to admission, he noticed lumps appearing first on his left elbow and then over other areas of the body. He complained of generalized joint pains and stated that he lost 40 pounds (18 kg.) in weight. His past history revealed that a mixed tumor of the right parotid gland had been excised thirty years previously and that the left eye was enucleated following trauma.

Examination disclosed a poorly nourished,

soft tissues. There was considerable soft tissue swelling about the area of bone involvement.

Necropsy revealed a foul smelling, ulcerated, grayish-black tumor in the skin of the right cheek, measuring 2.5 by 1.0 cm. There were numerous subcutaneous nodules over the entire body varying from 0.3 to 5.0 cm. in diameter. They were sharply circumscribed, freely movable, grayish-black in color and firm in consistency. There were five tumor masses in the

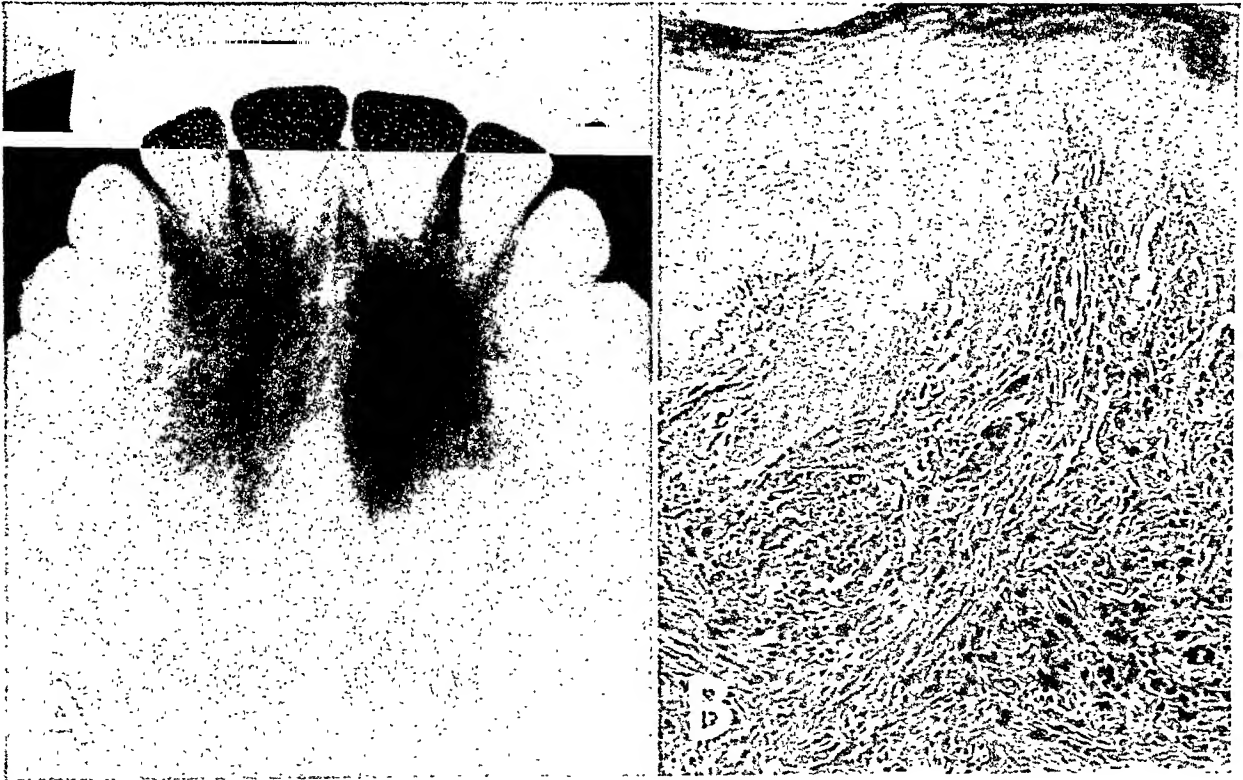


FIG. 3. Case III. *A*, showing an osteolytic lesion in the right maxilla. A few bony striae can be seen traversing a rather uniform area of translucency. *B*, photomicrograph showing the dermis and dermal papillae thickly invaded by large, darkly pigmented, spindle shaped cells. Clumps of these neoplastic cells are also seen in the capillaries and lymphatics ($\times 100$).

weak and ill looking man, with multiple subcutaneous nodules, an ulcerating tumor of the right cheek measuring 3 cm. in diameter and a swelling of the lower third of the right femur. The erythrocyte count was 2.65 to 2.80 million per cu. mm. He died one month after admission.

Roentgenographic examination revealed a metastatic process in the distal shaft of the femur characterized by an irregular area of rarefaction which gradually faded off into normal bone density. The periosteum and cortex showed an interruption in their normal contour and irregular fragments of bone could be seen projecting from the cortex into the adjacent

mucosa and the submucosa of the stomach, one in the duodenum, thirty-three in the small intestine and five in the large intestine. They were pedunculated or sessile in character and varied from 0.2 to 5.0 cm. in diameter. There were metastatic foci in the mesenteric, aortic and mediastinal lymph nodes, myocardium, peritoneum, pancreas, right kidney and suprarenal gland, brain, right clavicle and the lower end of the right femur.

CASE III. A female, Negro, aged thirty, complained of a painful growth on the roof of the mouth and swelling on both sides of the face.

About two months before admission to the hospital, she noticed a small lump on the roof of the mouth which rapidly increased in size. A month later, the sides of the face became swollen and painful. Examination disclosed a sessile, macerated, ulcerated, grayish-white lesion involving the entire hard palate and most of the soft palate with moderate induration of the surrounding tissue. The lymph nodes of the submaxillary and anterior cervical region bilaterally were enlarged, firm and tender. The erythrocyte count was 4.37 million per cu. mm.

Further roentgenograms revealed diffuse pulmonary metastasis.

A biopsy of the roof of the mouth revealed an invading tumor in the dermis composed mainly of irregular, large spindle-shaped cells that were heavily pigmented with dark brown pigment. The cells were irregularly arranged and extended beyond the confines of the biopsied section. The diagnosis was malignant melanoma.

CASE IV. A female, white, aged twenty-nine, who has been under observation during the past

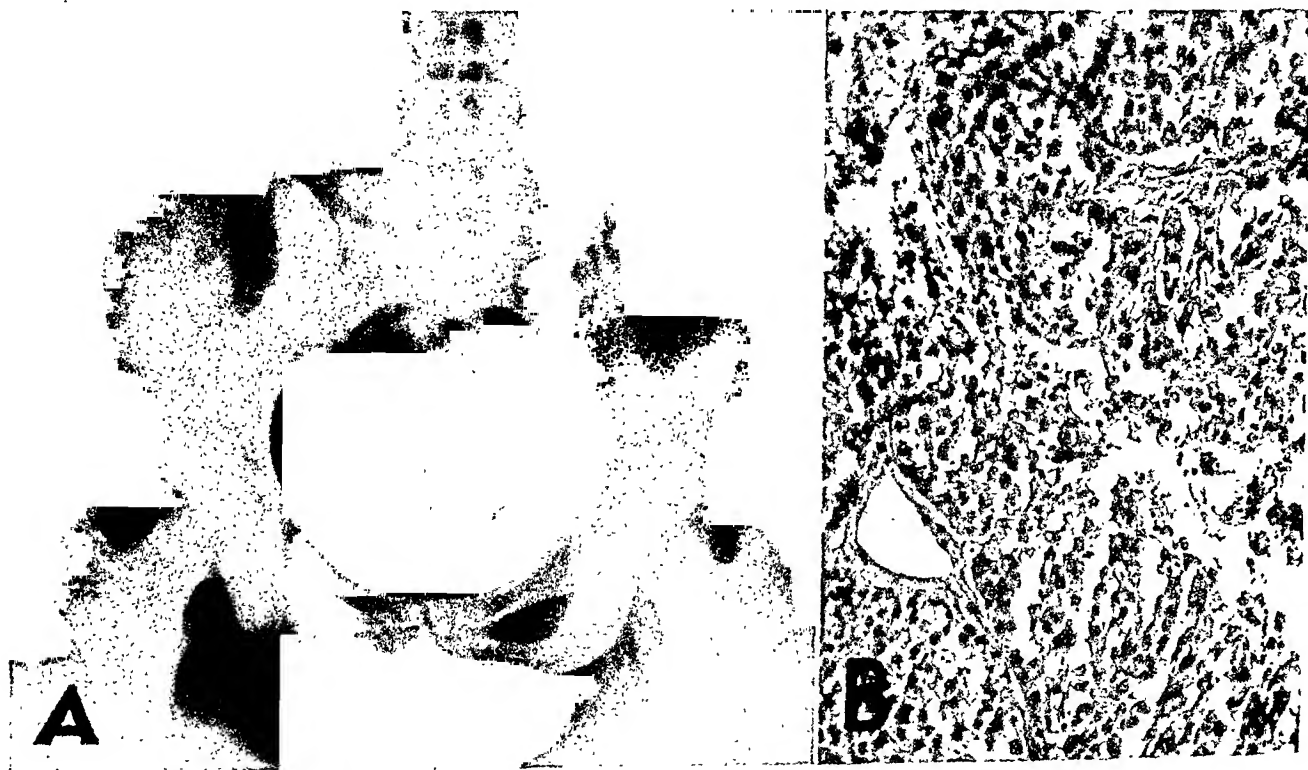


FIG. 4. Case IV. *A*, showing secondary metastasis in the right innominate bone. There are multiple areas of rarefaction interrupted by coarse bony spicules producing a "moth-eaten" type of bone destruction. The ragged and ill-defined contour indicates cortical involvement. *B*, photomicrograph of a lymph node biopsy, showing a replacement of the normal lymph node architecture by large masses of neoplastic cells. There are intracellular and extracellular deposits of dark brown pigment ($\times 200$).

The leukocyte count was 15,600 per cu. mm. The Wassermann and Kahn reactions were negative. The patient was treated locally with radium and deep roentgen therapy to the chest. She died five months after her first visit to the tumor clinic. A necropsy was not obtained.

Roentgenographic examination revealed a rather uniform area of radiolucency in the right maxilla. A few bony striae could be seen traversing the area of bone destruction. The lesion was sharply delimited medially by the median palatine suture while laterally it faded off into normal bone density. The remainder of the bony skeleton was negative for metastasis.

three years for metastatic malignant melanoma, began complaining of pain in her right hip. The patient stated that she first noticed a pinhead-sized growth on a toe of her right foot eleven years ago. Because the growth increased in size, she had it removed seven years later. At the time of removal, she was informed that the lesion was premalignant. One year later, the right femoral lymph nodes became enlarged to about 5-6 cm. in diameter. The leukocyte count was 12,800 per cu. mm. The enlarged femoral lymph nodes were excised and diagnosed as metastatic malignant melanoma. Roentgenograms of the chest and skull were

posits in bone are all of the osteolytic type, but they show considerable variations in the nature of the lysis. Some of the bone lesions were cyst-like in character with dense margins of reactive bone, while the margins of other lesions were ill defined, gradually fading off into the normal bony architecture. Irregular bony lamellae were noted in several cases tending to produce a honeycomb appearance. In one instance a spotty, moth-eaten type of bone destruction was demonstrable. In several cases, the overlying cortex and periosteum were destroyed without evidence of periosteal new bone formation.

These lesions are not unlike those seen in other osteoclastic diseases such as metastatic carcinoma, lymphosarcoma, leukemia and Hodgkin's disease, while the lesions demonstrated in the skull may be mistaken for fibrous dysplasia or cholesteatoma (except that they are usually solitary lesions).

CONCLUSIONS

1. Skeletal metastasis was investigated either by roentgen or necropsy examination in eighty-three patients with the diagnosis of malignant melanoma.

2. Of these eighty-three cases with malignant melanoma, nine cases, or 10.84 per cent, revealed skeletal metastasis.

3. Bone metastasis is more common than is generally realized. A more thorough bone survey by means of roentgen and necropsy

examinations would undoubtedly uncover a greater number of cases.

4. The roentgenological findings are by no means specific for this disease.

5. The cases in our series showing metastatic deposits in bone are all of the osteolytic type, but vary considerably in the nature of the bone destruction.

The authors wish to extend their appreciation to Dr. James Surver, Clinical Director of the Department of Neoplastic Diseases, for his assistance in the preparation of this paper.

Jefferson Hospital
Philadelphia 7, Pa.

REFERENCES

1. AFFLECK, D. H. Melanomas. *Am. J. Cancer*, 1936, 27, 120-138.
2. DALAND, E. M., and HOLMES, J. A. Malignant melanomas. *New England J. Med.*, 1939, 220, 651-660.
3. DE CHOLNOKY, T. Malignant melanoma; clinical study of 117 cases. *Ann. Surg.*, 1941, 113, 392-410.
4. GESCHICKTER, C. F., and COPELAND, M. M. Tumors of Bone. American Journal of Cancer, New York, 1931.
5. HOWES, W. E., and BIRNKRANT, M. Melanoma. *Am. J. Surg.*, 1943, 60, 182-189.
6. LIVINGSTON, S. K. Melanoma of the lumbar region without apparent skin manifestation; case report. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 46-48.
7. MOERSCH, F. P., LOVE, J. G., and KERNOHAN, J. W. Melanoma of central nervous system. *J.A.M.A.*, 1940, 115, 2148-2155.
8. RUSSO, P. E. Malignant melanoma in infancy. *Radiology*, 1947, 48, 15-19.



COLLAPSE OF THE VERTEBRAL BODIES IN SICKLE CELL ANEMIA*

By WILLIAM A. HENKIN, M.D.

NEW YORK, NEW YORK

THE reported osseous manifestations of sickle cell anemia have been many and varied.^{2,3,5,12,14} Only rarely, however, has the occurrence of collapse of the vertebral bodies been noted.

Changes in the vertebral bodies were apparently first described in 1932 by Leivy and Schnabel¹⁰ in their paper on abdominal crises in sickle cell anemia. Their Case 1 was a Negro male, aged twenty-five, hospitalized in October, 1926, because of severe pains in the arms and legs. The skull showed "considerable thickening of the outer table of the parietal bone. This was due to new bone formation, showing as striations perpendicular to the long axis of the skull." In the spine "the vertebrae were shortened in their vertical dimensions and somewhat widened in diameter. They had a soft appearance, there being considerable decalcification. The trabeculae were rather prominent and sharp and the cancellous spaces were rather large."

In 1937 Diggs, Pulliam and King⁴ presented the most thorough discussion of the pathological and roentgenographic changes in sickle cell anemia. They noted that the vertebrae "show, as do the other cancellous bones, diffuse and localized variations in radiability. In addition there is, in adults with the disease, flattening of the vertebral bodies. . . . Average measurements of the height and width of the first four lumbar vertebral bodies in the anterior-posterior and lateral views revealed a greater height-to-width ratio in sickle cell anemia patients than in normal controls." The height-to-width ratios in 14 normal Negro adults was 1:1.4 in the anteroposterior view and 1:1.2 in the lateral view. In 7 patients with sickle cell anemia the mean height-to-width ratio was 1:1.9 in the anteroposterior view. For 8 other patients with sickle cell anemia

the mean height-to-width ratio was 1:1.45 in the lateral view. There was no apparent relation between the age of the patient and the magnitude of the vertebral body changes.

The same vertebral body changes were observed by Weens¹⁵ in 1945 incidental to a paper on cholelithiasis in sickle cell anemia. The roentgenographic report in his Case 1 stated that "the dorsal and lumbar vertebrae showed a rather coarse trabeculation and were somewhat osteoporotic. The vertebral bodies appear decreased in height and increased in width."

Kraft and Bertel⁹ in 1947 reported a case of sickle cell anemia in a Negro male, aged forty-three. The following roentgenographic changes were noted in the spine: "Ballooning of cervical discs with biconcave shape of cervical bodies. Coarse trabeculation of vertebrae. Thinning of thoracic discs and exaggeration of thoracic curve. Flattening, lipping and coarse trabeculation of thoracic bodies with porotic areas posteriorly." In the lumbosacral spine, "lipping and flattening also sclerotic and porotic areas of vertebral bodies as seen in the thoracic area. Ballooning of discs as found in the cervical region. Exaggeration of the lumbosacral curve."

CASE REPORTS

CASE 1. H. W., Negro, male, aged fourteen, was first admitted to Morrisania City Hospital on December 4, 1946, because of a draining left pretibial ulcer.

Since the age of three this boy had had innumerable attacks of muscle and joint pains, frequently accompanied by chills, fever, abdominal pain and jaundice, and occasionally by dyspnea on effort, palpitation and precordial pain. There had been no nausea or vomiting. At the age of three, his left leg was swollen. Thereafter, frequently after only moderate trauma, the skin over the anterior surface of the

* From the Department of Radiology, Morrisania City Hospital, New York, Dr. Samuel F. Weitzner, Director.

left tibia had broken down, draining seropurulent fluid for varying periods of time. Splenectomy was performed when the patient was four years of age. No change in the frequency or severity of the attacks was perceptible post-operatively.

Positive findings on physical examination of this thin but well developed Negro boy were



FIG. 1. Case 1. Left tibia, demonstrating anterior bowing, coarse trabeculation and cortical thickening. These changes bear a striking resemblance to those seen in Paget's disease.

slight icterus, small shotty axillary, epitrochlear and inguinal lymph nodes and a well healed scar of a left pararectus incision. There was pronounced anterior bowing of the left tibia with a yellow-crust ulcer about 4 cm. in length overlying the anterior surface of the leg.

Examination of the blood disclosed a red blood cell count of 2,400,000 with a hemoglobin of 58 per cent and a white blood cell count of 9,250, with 39 per cent neutrophils, 52 per cent lymphocytes, 8 per cent eosinophils and 1 per cent basophils. On direct smear marked aniso-

cytosis and poikilocytosis as well as sickling were noted. There was 90 per cent sickling on a twenty-four hour wet preparation. Urinalysis was negative as was the blood Kahn test. Blood chemistry studies revealed a normal blood sugar and urea nitrogen, an icterus index of 17 with the qualitative Van den Bergh direct-negative, indirect-positive.

Roentgenograms of the skull showed no abnormalities. The long bones were all normal with the exception of the left tibia (Fig. 1)



FIG. 2. Case 1. Dorsolumbar spine.

which showed considerable anterior bowing, coarsening of the trabecular structure and cortical thickening.

During his hospital stay he complained of muscle and bone pains in both upper and lower extremities. A low grade temperature ranging as high as 100.2° F. gradually returned to normal. Symptomatic therapy, two 500 cc. blood transfusions and wet dressings to the draining pre-tibial ulcer produced marked improvement. Pains abated, hemoglobin rose to 75 per cent, the draining ulcer healed and the patient was discharged on December 21, 1946.

He remained well until June 9, 1947, when he developed pain in the lumbosacral region and fever.

On admission to the hospital jaundice was not observed. The temperature was 100.8° F. The previously noted left pretibial ulcer was healed. There were no other significant findings.

Examination of the blood disclosed a red blood cell count of 3,490,000 with 11 grams of hemoglobin and a white blood cell count of 12,900, with 70 per cent neutrophils, 22 per cent lymphocytes and 8 per cent monocytes. Poikilocytosis and sickling were noted on direct smear with 70 per cent sickling seen on a twenty-four hour wet preparation. The icterus index was 18, the serum calcium 11.3 mg. per 100 cc., the serum phosphorus 3.6 mg. per 100 cc., the serum alkaline phosphatase 7.8 King-Armstrong units. A qualitative Sulkowitsch test revealed increased urinary calcium excretion.

On July 14, five weeks after admission the red blood cell count was 2,780,000 with 8.5 grams of hemoglobin and a white blood cell count of 11,400, with 43 per cent neutrophils, 50 per cent lymphocytes and 7 per cent eosinophils. Seven per cent reticulocytes were noted as well as sickling on direct smear.

Fever and pains gradually disappeared and

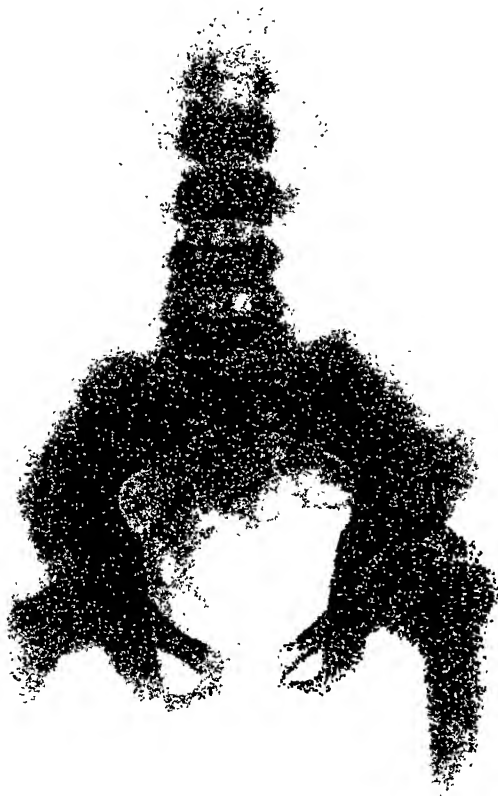


FIG. 3. Case I. Lumbar spine and pelvis.



FIG. 4. Case I. Lumbar spine, lateral view, showing collapse of the vertebral bodies with coarsening of the trabecular structure and ballooning of the intervertebral discs.

the patient was discharged. Six weeks after discharge a repeated serum calcium determination was 11.1 mg. per 100 cc. and an alkaline phosphatase determination was 12.8 King-Armstrong units.

Roentgenographic studies, during this admission, of the spine and pelvis were of unusual interest (Fig. 2, 3 and 4). The bodies of all the thoracic and lumbar vertebrae showed coarsened trabecular structure with considerable diminution in height. This flattening of the vertebral bodies was accompanied by ballooning of the intervertebral discs. The cervical spine showed no abnormalities. Averaged measurements of the involved vertebrae, as suggested by Diggs, Pulliam and King,⁴ gave the following ratios (Table I):

TABLE I
HEIGHT-WIDTH RATIOS—CASE I

	Antero-posterior View	Lateral View
Thoracic vertebrae	1:2.3	1:1.7
Lumbar vertebrae	1:1.8	1:1.7

CASE II. J. C., female, Negro, aged twelve and a half, was admitted to Morrisania City Hospital for the sixteenth time on December 4, 1947, because of the sudden onset of pain in the left knee.

At the age of three she was admitted to another hospital because of anorexia and pain in the back and legs. On physical examination shotty, generalized lymphadenopathy was ob-

58 per cent lymphocytes and 24 per cent nucleated red cells. There were 200,000 platelets. On direct smear anisocytosis, poikilocytosis and a few sickle cells were noted. A twenty-four hour wet preparation showed 95 per cent sickling. A fragility test showed no hemolysis 0.72-0.44 and partial hemolysis 0.40-0.24. Examination



FIG. 5. Case II. Lateral lumbar spine shows ballooning of the intervertebral discs and slight central compression of the vertebral bodies.

served. The spleen was palpable 3 cm. below the costal margin; the liver, 1 cm. below the costal margin. A blowing systolic murmur, maximal at the apex, was audible over the entire precordium and was transmitted to the left axilla.

Examination of the blood disclosed a red blood cell count of 2,580,000 with a hemoglobin of 40 per cent and a white blood cell count of 13,000, with 30 per cent adult neutrophils, 8 per cent juveniles, 4 per cent metamyelocytes,

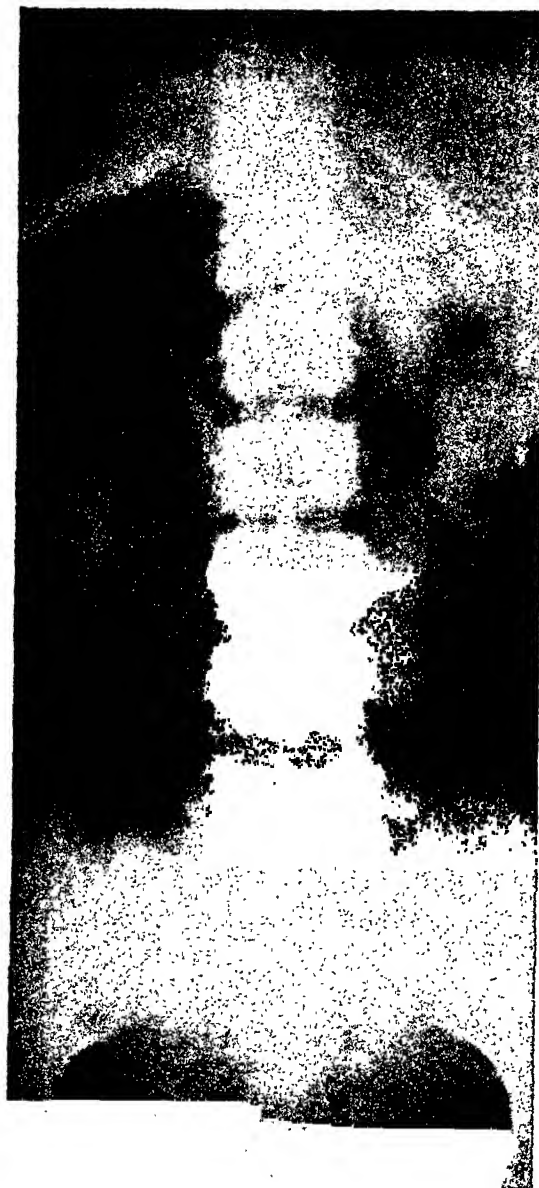


FIG. 6. Case II.

of the bone marrow revealed a hyperplastic, erythroblastic bone marrow with the most bizarre nuclear degeneration.

Roentgenograms of the skull and long bones showed no abnormalities. Mantoux test, Wassermann reaction and urinalysis were negative.

Under treatment with iron the hemoglobin rose to 52 per cent and the red blood cell count to 3,630,000. The spleen became somewhat smaller and the patient was discharged two weeks after admission with the diagnosis of sickle cell anemia.

Subsequently she was admitted to Morristown City Hospital on sixteen occasions. Three admissions were for lower lobe lobar pneumonias confirmed by roentgenograms and responding well to chemotherapy. The remainder were for abdominal pain, pain in various joints, low back pain, or transfusion. A low grade fever, red blood cell counts ranging between 2,000,000 and 3,600,000, icterus indices varying from 12 to 27 and normal roentgen studies characterized these admissions, the diagnosis in each case being sickle cell anemia in crisis.

Symptoms and findings on December 4, 1947, were similar to those on previous admissions. However, roentgenograms of the lumbar spine showed slight coarsening of the trabecular structure and broadening of the lumbar vertebral bodies. There was no appreciable diminution in height except centrally where there was considerable ballooning of the intervertebral discs (Fig. 5 and 6).

DISCUSSION

The following is the probable pathological basis for the roentgenographic changes in the vertebral bodies. Bone marrow examined both at autopsy and after bone biopsy is generally dark red in color and jelly-like in consistency. Microscopically great cellularity and congestion are noted. As in other organs of the body, congestion is frequently followed by thrombosis, infarction and connective tissue replacement of parenchyma. Sections may show, in addition, hemorrhage, granular and crystalline pigment deposits, hyalinization and abnormal calcification.⁴ The resultant weakened bone, subject to excessive stresses, may show a tendency toward compensatory new bone formation.

It would appear, therefore, that two processes—trabecular destruction with connective tissue replacement, and new bone formation in the remaining trabeculae—develop simultaneously. The former produces gradual bone resorption manifested roentgenographically by a decrease in the number of bone trabeculae and by a general decrease in density of the affected bone. The latter produces an increase in the size of the remaining trabeculae, manifested roentgenographically by a coarsening of the

trabecular structure and by a general increase in density of the affected bone. These changes occur primarily in the most erythropoietic portions of the bony skeleton, cancellous bone.

The connective tissue replacement of bony trabeculae is associated with a numerical decrease in osteoblasts rather than with any decrease in activity of the osteoblasts that remain. When the net result is that the osteoblasts do not lay down sufficient osseous matrix, the bone changes may be regarded as basically those of osteoporosis. "Since osteoporosis is not really a disease of calcium metabolism it is not surprising that the serum calcium and phosphorus levels are normal."¹ The serum alkaline phosphatase level, a measure of osteoblastic activity, is also within normal limits in osteoporosis.

In the vertebral bodies which are subject to the greatest mechanical stresses the coarsened trabeculae may prove incapable of giving adequate strength to the osteoporotic bone. A gradual collapse of the weakened vertebral bodies ensues. All the lumbar, most of the thoracic and, occasionally, some of the cervical vertebral bodies are involved. The extent of the changes is directly proportional to the duration of the disease, the severity of the anemia, and the body weight. It is for these reasons that the reported cases are in adults rather than in children.

The collapse occurs more or less simultaneously in all the affected vertebral bodies. It may be accompanied by mild or moderately severe, transient, self-limited, frequently recurring, poorly localized back pain.

The collapsed vertebral bodies show increased coarseness of the trabecular structure with coarse striations running superiorly-inferiorly. The bone density is as great as or perhaps greater than that of normal bone. As the intervertebral discs expand into the collapsing vertebral bodies, the latter assume a biconcave shape, the so-called "fish vertebrae."

The process differs only slightly from

senile osteoporotic collapse of the vertebral bodies¹¹ which is preceded by generalized bone atrophy and decalcification unaccompanied by coarsening of the trabecular structure. Senile collapse is often complicated by true pathological compression fractures of the vertebral bodies, an as yet undescribed occurrence in sickle cell anemia.

No similar changes in the vertebral bodies have been described in either Cooley's anemia or congenital hemolytic anemia despite the basic pathological similarity of the three diseases.

There appears to be a thought-provoking similarity between the osseous changes occurring in sickle cell anemia and those occurring in Paget's disease. The latter have been described¹ as developing in three stages: (a) destruction of bone due to an unknown cause; (b) osteoblastic stimulation due to increased stresses and strains; (c) overgrowth of bone and increase of the serum phosphatase level as a result of osteoblastic stimulation. "The original observation of Paget that the bone in osteitis deformans is hyperemic is certainly correct."¹³ (The bone marrow hyperemia found consistently in sickle cell anemia should be recalled.) Skin temperatures are consistently and significantly higher over a portion of an extremity showing Paget's disease than over the corresponding portion of the opposite normal extremity. In Paget's disease the serum calcium and inorganic phosphorus levels are almost invariably normal. The alkaline serum phosphatase is elevated in proportion to the extent of osteoblastic bone involvement. In osteoporosis circumscripta of the skull, which appears to be a form of, or a stage in the development of, Paget's disease,⁸ only the first stage of Paget's disease, destruction of bone due to an unknown cause, is present. The serum phosphatase is normal and there is hypofunction of the osteoblasts in the involved area. Roentgenographic examination of the lumbar vertebrae often shows vertebral body flattening very similar to that seen in sickle cell anemia except that the trabecular structure is much coarser.

Depending upon the degree of coincident osteoporosis, ballooning of the adjacent discs may accompany the vertebral body flattening.

Another disease in which bone changes in the vertebral bodies should be expected is polycythemia vera. The bone marrow is extremely hyperplastic. Thromboses and hemorrhages are common complications. Yet a complete review of the literature has unearthed only one case⁶ in which a relation between bone changes and polycythemia was noted. The patient was a white male, aged fifty-five, with a history of known polycythemia of thirty-one years' duration. At autopsy "in the bodies of the lumbar vertebrae the tan-red marrow was reduced to approximately one fifth of the usual volume. The bone trabeculae in the vertebrae were markedly thickened and the dimensions of the marrow spaces were correspondingly reduced. Along the edges of the trabeculae were narrow layers of newly deposited bone." Hirsch concluded that "the generalized osteosclerosis noted in the bones of this patient with polycythemia vera probably is a change occurring in the advanced chronic stages of the disease."

In 1946 Hodgson, Good and Hall⁷ analyzed roentgenograms of 88 proved cases of polycythemia vera without finding any bone lesions attributable to the disease.

SUMMARY

Two cases of sickle cell anemia, one in a Negro boy, aged fourteen, with osteoporotic collapse of the thoracic and lumbar vertebral bodies and the other in a Negro girl, aged twelve and a half, with similar changes in the lumbar vertebral bodies are presented. This is believed to be the first report of this finding in children.

In sickle cell anemia hemolysis of abnormal erythrocytes is followed by an intense erythropoietic reaction in the bone marrow with congestion, infarction and connective tissue replacement of cancellous bone. Coarsening of the trabecular structure is evidence of osteoblastic reaction in the weakened bone. The thoracic and

lumbar vertebral bodies, composed of cancellous bone and subject to great stresses, may show a gradual reduction in height.

Similar changes occur in Paget's disease (osteitis deformans). In senile osteoporotic collapse of the vertebral bodies there is no roentgenographic evidence of osteoblastic activity. Polycythemia vera, a disease in which hemorrhage and thrombosis are common complications, shows no bone changes similar to those found in sickle cell anemia; nor are such changes seen in Cooley's anemia or congenital hemolytic anemia.

20 Plaza St.

Brooklyn 17, N. Y.

ADDENDUM

Since submission of this manuscript two excellent relevant papers have appeared: LeGant, O., and Ball, R. P. Sick cell anemia in adults; roentgenographic findings. *Radiology*, 1949, 51, 665-675; and Macht, S. H., and Roman, P. W. The radiologic changes in sickle-cell anemia. *Radiology*, 1949, 51, 697-707. The former describes 4 cases, aged twenty-five, twenty-six, thirty-two, and sixteen, with similar changes in the vertebral bodies; the latter also records 4 such cases but does not state the patients' ages.

REFERENCES

1. ALBRIGHT, F., SMITH, P. H., and RICHARDSON, A. M. Postmenopausal osteoporosis. *J.A.M.A.*, 1941, 116, 2465-2474.
2. CAFFEY, J. Skeletal changes in the chronic hemolytic anemias (erythroblastic anemia, sickle cell anemia and chronic hemolytic icterus). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 293-324.
3. DANFORD, E. A., MARR, R., and ELSEY, E. C. Sick cell anemia, with unusual bone changes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 45, 223-226.
4. DIGGS, L. W., PULLIAM, H. N., and KING, J. C. Bone changes in sickle cell anemia. *South. M. J.*, 1937, 30, 249-259.
5. GRINNAN, A. G. Roentgenologic bone changes in sickle cell and erythroblastic anemia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1935, 34, 297-309.
6. HIRSCH, E. F. Generalized osteosclerosis with chronic polycythemia vera. *Arch. Path.*, 1935, 19, 91-97.
7. HODGSON, J. R., GOOD, C. A., and HALL, B. E. Roentgenographic aspects of polycythemia vera. *Proc. Staff Meet., Mayo Clin.*, 1946, 21, 152-157.
8. KASABACH, H. H., and GUTMAN, A. B. Osteoporosis circumscripta of the skull and Paget's disease. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 577-602.
9. KRAFT, E., and BERTEL, G. Sick cell anemia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 57, 224-231.
10. LEIVY, F. E., and SCHNABEL, T. G. Abdominal crises in sickle-cell anemia. *Am. J. M. Sc.*, 1932, 183, 381-391.
11. MARUM, G. J. Roentgenographic observations in age atrophy and osteoporosis of the spine. *Radiology*, 1946, 46, 220-226.
12. MOORE, S. Bone changes in sickle cell anemia, with note on similar changes observed in skulls of ancient Mayan Indians. *J. Missouri M. Ass.*, 1929, 26, 561-564.
13. SNAPPER, I. Medical Clinics on Bone Diseases. Interscience Publishers, Inc., New York, 1943.
14. VOGT, E. C., and DIAMOND, L. K. Congenital anemias, roentgenologically considered. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 625-630.
15. WEENS, H. S. Cholelithiasis in sickle cell anemia. *Ann. Int. Med.*, 1945, 22, 182-191.



EVALUATION OF PLANIGRAMS IN PULMONARY TUBERCULOSIS*

By PHILIP MORGENSTERN, M.D., F.A.C.P., CHARLES E. CARR, M.D., and
WALTER L. NALLS, M.D., F.A.C.P.

ALTHOUGH the introduction of antibiotics has raised the hope of eventually eliminating pulmonary tuberculosis by a single potent therapeutic agent, closure of cavities still remains one of the cornerstones in our present-day program of treatment. Any method of examination which helps to diagnose cavities more accurately is of considerable value.

Body section roentgenography is such a method. Although it has been in use under various names (planigraphy, laminagraphy, tomography, etc.) for almost twenty years,^{1,4,5,6} it is still looked upon with skepticism by many roentgenologists and chest physicians. This attitude is due largely to the fact that there are many confusing shadows on the planigrams which are not seen on the conventional film. Unless a serious attempt is made to correlate these shadows with the actual lung findings, correct interpretation may prove very difficult.

Very few articles in the English literature deal with this phase of the subject. Epstein and his coworkers² in 1940 examined 10 cadavers shortly after death by means of tomograms and then compared the roentgen shadows with the lung findings at necropsy. They called attention to several pitfalls in the diagnosis of cavitation.

Our study attempted to check the accuracy of the planigraphic interpretations by correlating them with the sputum findings as well as with the actual lung findings in those cases which were treated by pulmonary resection. Three hundred consecutive sets of planigrams were reviewed. Twenty-three patients had had either lobectomy or pneumonectomy one to seven

weeks after the planigrams were made and the interpretation could be checked with the actual lung specimen. The others were followed by careful check of the sputum and clinical course for periods of from five or six months to two years after the planigrams were made. This method, of course, is not as accurate as the correlation with resected lung specimens. With rare exceptions, however, it is justifiable to assume that a true tuberculous cavity will sooner or later give a positive sputum for tubercle bacilli. The presence of an annular shadow on a planigram with persistently negative sputum for six months or a year indicates that the suspicious density is probably not a cavity. Roentgenoscopy was also used liberally to check on the identity of suspicious oval or annular densities where diagnosis was still in doubt.

Using this approach, we came to certain definite conclusions:

A. Rigid criteria must be used in the diagnosis of cavity on planigrams:

1. There must be a complete, sharply defined, oval or annular density surrounding an area of increased radiolucence, usually showing on two or more roentgenograms at consecutive levels.
2. The walls of the suspected cavity must be clearly identified apart from adjacent structures such as pleura, rib, pulmonary vessel, or fibrous strand.
3. The suspected cavity should correspond in location with the site of the original cavity in cases where collapse therapy has been done.
4. In the case of a large radiolucent area within a dense post-thoracoplasty lung, identification of a bronchus leading into or stopping just short of the suspicious "high-

* From the Department of Medicine and Surgery, Veterans Administration, Oteen, North Carolina. Published with permission of the Chief Medical Officer, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

light" is helpful in diagnosis of cavity. However, it was clearly seen in only 5 per cent of our cases.

B. Planigrams are most helpful in certain types of cases. These include:

1. Dense post-thoracoplasty lungs—the planigram is much more conclusive than a roentgenogram taken using the Potter-Bucky grid.

2. Extrapleural lucite pack—residual cavity may be obscured by the lucite balls on the conventional or Potter-Bucky film, but will usually be clearly demonstrated on planigram.

3. Inspissated cavity—this will show only as a uniform round or oval density on a plain roentgenogram but planigrams may reveal the central rarefaction within the caseous mass.

4. Dense fibrocaseous lesions.

Planigrams are of limited value in the following types of disease:

1. Confluent nodular densities scattered throughout the lung in several planes. These represent areas of caseation which may have tiny ulcerations too small to be demonstrated on planigrams taken at levels 1 centimeter apart. Such cavities are usually characterized by varying periods of negative sputum interrupted by an occasional positive concentrate or culture. It is very rare for such a cavity to give a persistently positive sputum on plain smear.

2. Planigrams may fail to demonstrate a slit-like cavity with collapsed walls in a thoracoplasty lung. Some air must be present within a cavity in order to produce the characteristic radiolucent area.

3. Emphysematous blebs and bronchiectatic dilatations within a fibrotic upper lobe may be very difficult to distinguish from small tuberculous cavities.^{3,7} As a rule, however, emphysematous blebs tend to be more perfectly round and have thinner walls than tuberculous cavities. The extreme apical portion of the lung just beneath the pleura is a favorite site for emphysematous blebs.

In not a single case was a cavity dis-

covered on the planigram in an area where no infiltration was seen on the plain chest roentgenogram. It is therefore useless to take planigrams of a lung which appears normal on the conventional roentgenogram.

The following cases illustrate some of the points mentioned above.

CASE REPORTS

CASE I. E. C. B., a male, aged thirty, with a history of pulmonary tuberculosis since 1943. He had a six-rib thoracoplasty for cavitation in the left upper lobe. The sputum remained positive. Conventional roentgenogram showed moderate compression of the left upper lobe with a large ill defined highlight partly obscured by the thick overlying pleura. The Potter-Bucky roentgenogram was suggestive but not conclusive of cavitation (Fig. 1A). The planigram, however, showed a clearly demarcated 4 by 2 cm. cavity seen best on the 7 and 8 cm. levels, with two small bronchi leading to the lower border of the cavity (Fig. 1B). Cavernostomy was completed May 5, 1947, and the patient's sputum has been negative since July 22, 1947.

CASE II. A. P., a male, aged fifty-one. An extrapleural lucite pack operation was done on February 7, 1947, for a small cavity in the right upper lobe. Sputum, however, remained positive. On the plain film details of the compressed right upper lobe were obscured by the lucite balls (Fig. 2A), but the planigrams on March 25, 1947 and June 26, 1947 clearly showed the thick-walled residual cavity medial to the lucite pack (Fig. 2B). It was seen best on the 10 and 11 cm. films showing that it had been displaced far anteriorly by the lucite pack.

CASE III. B. D. M., a diabetic, aged thirty, who had pneumothorax on the left side for a tuberculous cavity in the upper lobe. Collapse was adequate and the roentgenogram showed a large caseous area at the site of the original cavity (Fig. 3A). Planigrams, however, showed a well demarcated, kidney-shaped area of radiolucence within the caseous mass, seen clearly on the 4, 5, and 6 cm. levels (Fig. 3B). Left upper lobectomy was done four weeks following planigrams and showed a partially inspissated cavity consisting of a hard cheesy periphery with a soft center containing greenish pus.

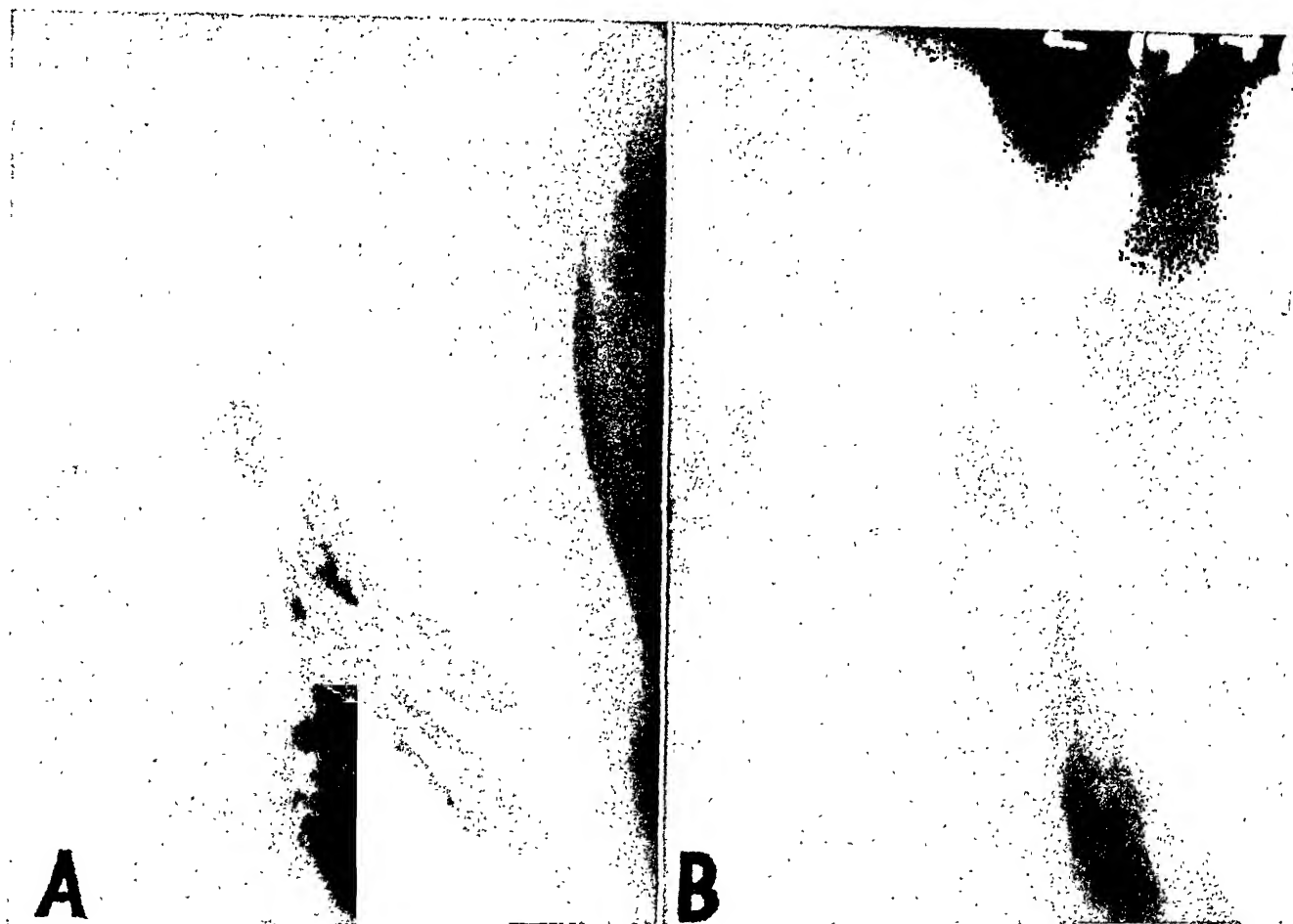


FIG. 1. Case I. *A*, Bucky film is merely suspicious of residual cavity in dense left upper lobe. *B*, planigram leaves no doubt about the presence of cavity. Bronchi are seen leading to the lower pole of the cavity.

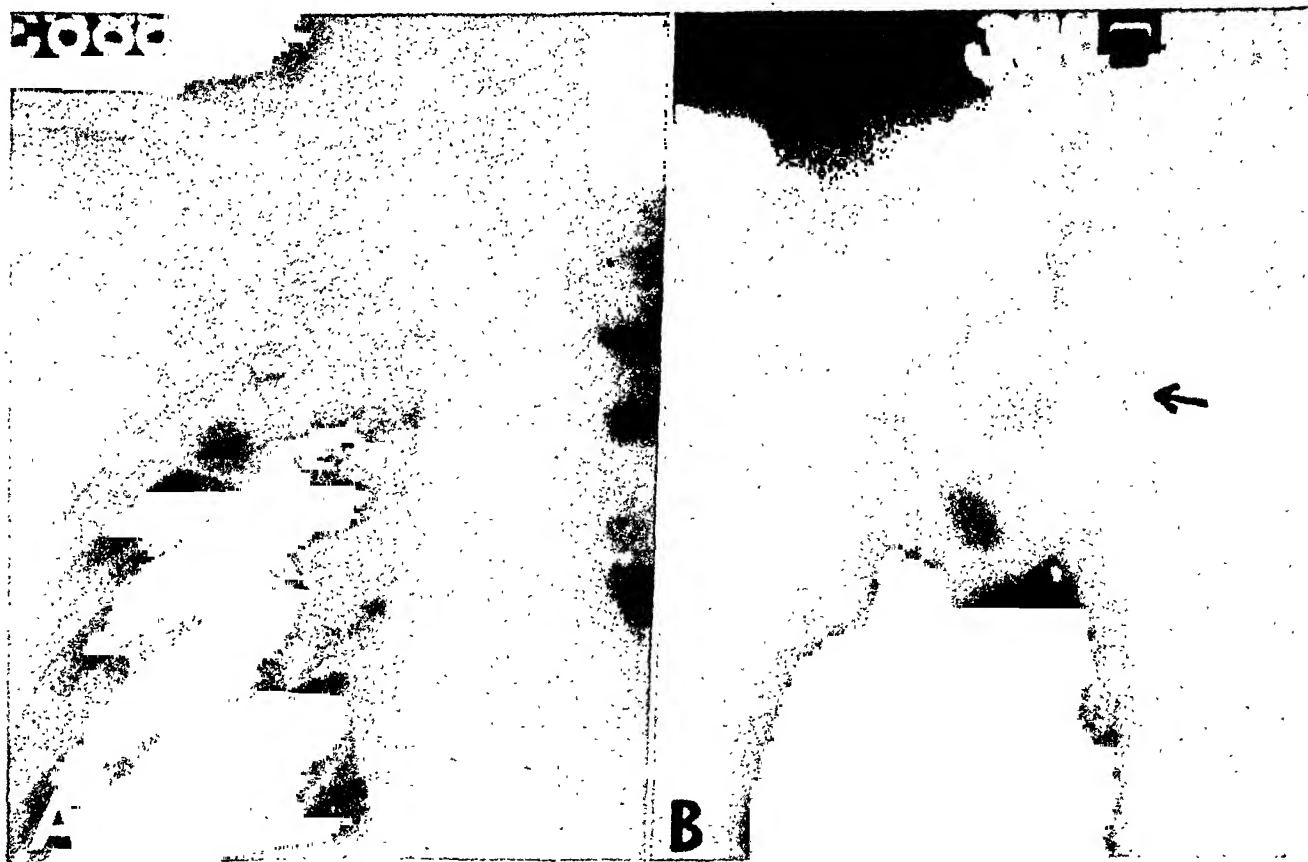


FIG. 2. Case II. *A*, extrapleural pack with residual cavity obscured by the lucite balls. *B*, planigram shows irregular cavity (arrow) medial to the perfectly spherical lucite balls.

CASE IV. E. K., a veteran, aged thirty-three, who was diagnosed as having pulmonary tuberculosis of the right upper lobe in 1945. He gave a history of a shrapnel wound of the right chest in November, 1942, which had healed uneventfully. Sputum had become negative for tubercle bacilli in April, 1946, but he continued to have repeated hemoptyses. Roentgen examination of the chest showed some strands of infiltration in the right supraclavicular region (Fig. 4*A*). Lipiodol studies showed no evidence of bronchi-

who had a seven-rib thoracoplasty on the right side for a large upper lobe cavity (Fig. 5*A*). Sputum, however, remained positive. Bucky film showed several suspicious but ill defined highlights within the dense right upper lobe (Fig. 5*B*). Planigrams revealed a well demarcated radiolucent area in the apical portion of the right upper lobe. It was seen clearly on the 6, 7, 8, 9, and 10 cm. levels and corresponded in location with the site of the original cavity. In addition, there was an irregu-

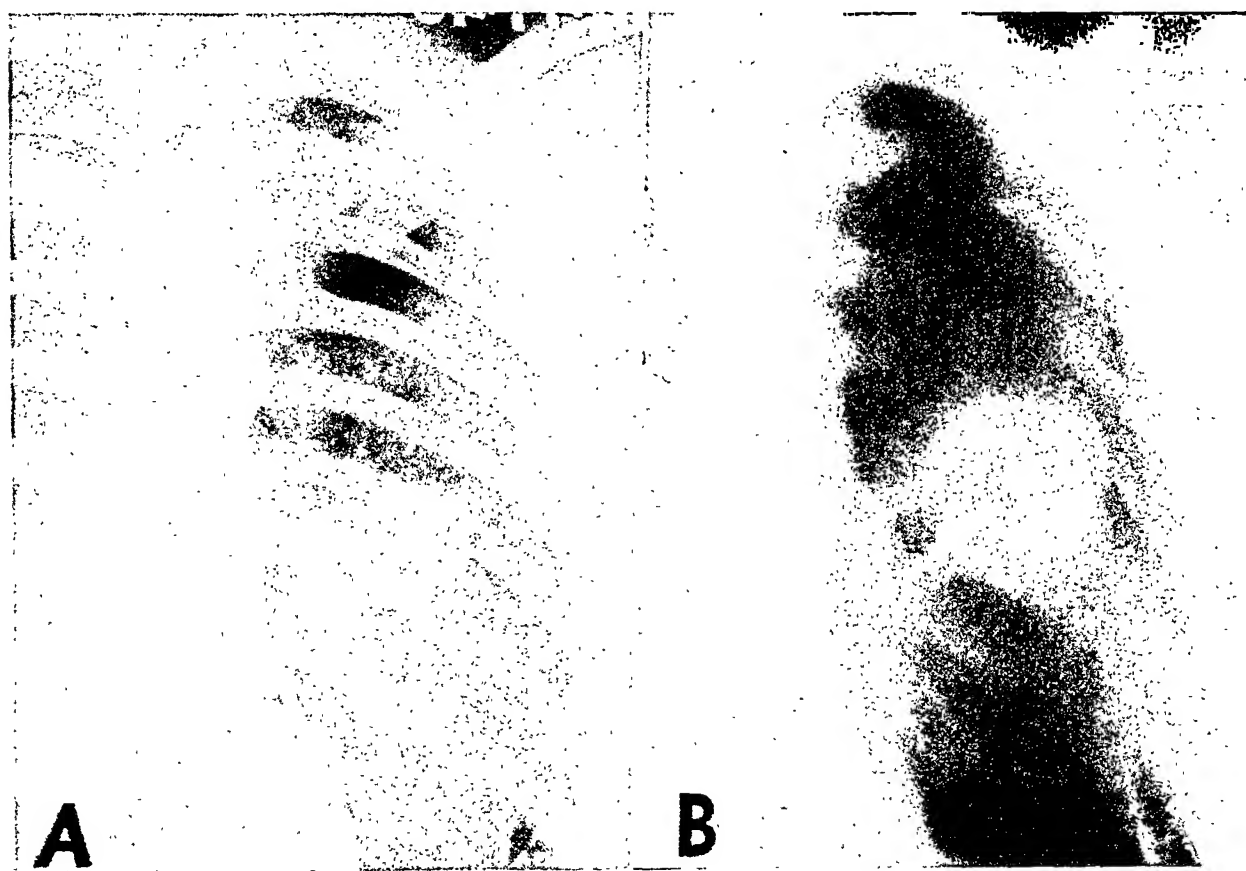


FIG. 3. Case III. *A*, conventional film shows dense caseous area in left mid-lung field. *B*, planigram clearly shows the central area of rarefaction within the caseous mass. The resected lobe showed a hard cheesy sphere with a soft center containing greenish pus.

ectasis. Planigrams showed an irregularly annular density just off the right hilum on the 5, 6, and 7 cm. films (Fig. 4*B*). However, it was not sharply delineated and its medial wall seemed to be formed by a branch of the pulmonary vessels. It was diagnosed as not being a cavity since it did not meet all the criteria. A right upper lobectomy was done April 10, 1947, because of the persistent hemoptyses and no definite cavity was found in the resected specimen.

CASE V. R. C., a veteran, aged twenty-eight,

larly oval radiolucent area in the basal portion of the right upper lobe just merging with the pleura (Fig. 5, *C* and *D*). However, it was not sharply delineated and did not correspond in location with any definite cavity prior to surgery. It was felt that this "highlight" represented normally aerated lung surrounded by thick pleura and areas of fibrosis. Lobectomy on January 23, 1947, proved this interpretation to be correct.

CASE VI. H. B., a World War I veteran, aged fifty-two, with a history of pulmonary tuber-

culosis since 1927. A three-stage left thoracoplasty was done in 1944 for a large cavity in the left upper lobe (Fig. 6A). Sputum, however, remained positive. On conventional chest film, details of the left lung were obscured by the very thick pleura. On the planigram, however, a large, irregular, radiolucent area was visible in the compressed left lung. A large bronchus could be seen leading directly into this area.

fied but a large, oval, radiolucent area is seen on several planigrams in the apical portion of the compressed left upper lobe (Fig. 7D). It does not correspond in location with any previous cavity and it is felt that it probably represents an area of normal lung surrounded by thick pleura and areas of fibrosis. The persistently negative sputum for eleven months with no change in the planigraphic appearance of

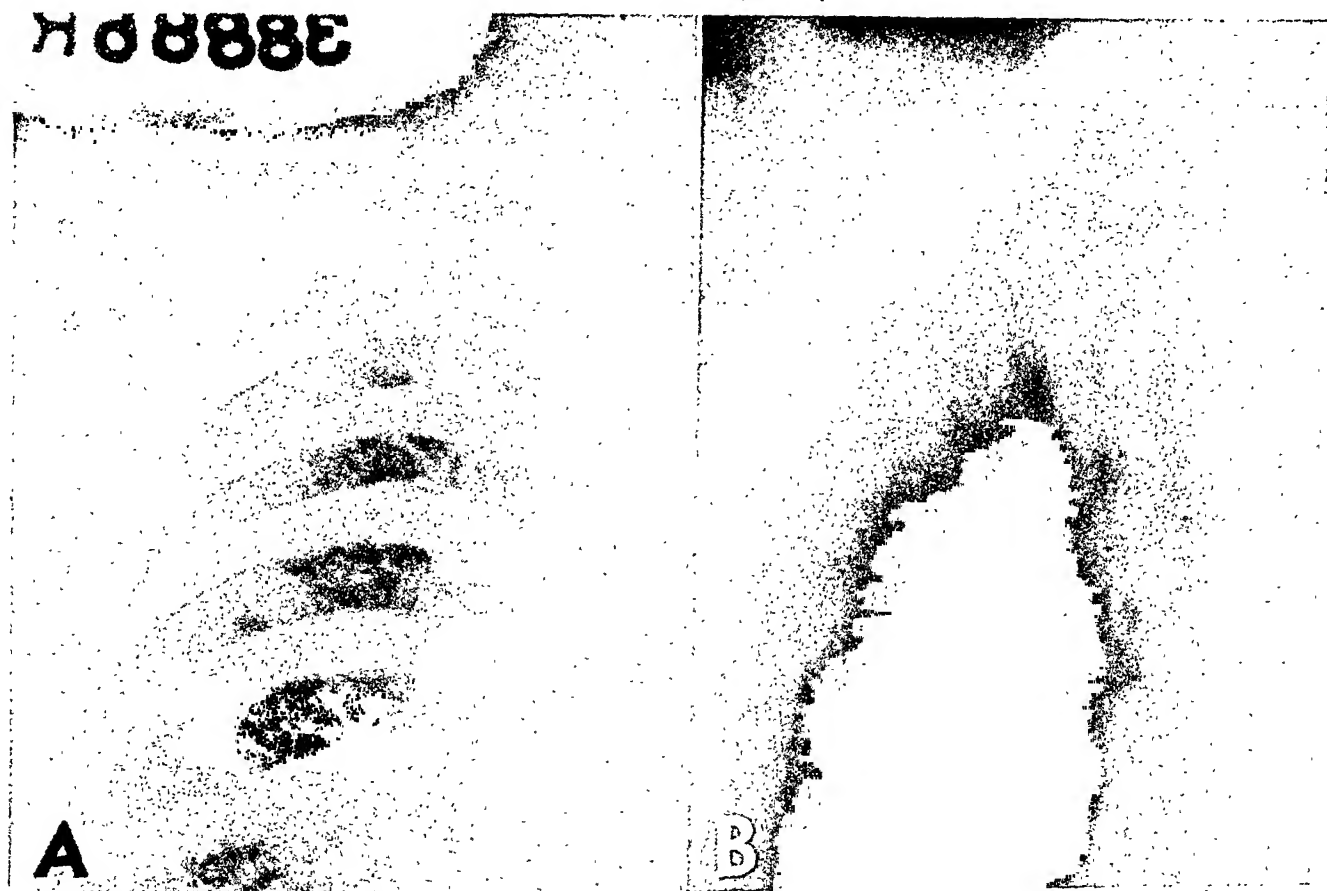


FIG. 4. Case IV. A veteran, aged thirty-three, with repeated hemoptyses. *A*, a few strands of infiltration are seen in the right infraclavicular region. Some old shrapnel fragments are noted in the right upper chest. *B*, planigram shows irregularly annular density just off the right hilum. Although it was seen at several levels, it was not sharply demarcated and seemed to be formed partly by vessel shadow. It was interpreted as not being a cavity. Confirmed at operation.

(Fig. 6, *B* and *C*). It was interpreted as a cavity. This was confirmed at pneumonectomy on June 17, 1947.

CASE VII. A. E., a colored male, aged thirty-two, diagnosed as having pulmonary tuberculosis in January, 1946. A roentgenogram showed a fibrocaseous lesion in the left upper lobe with a 2 cm. cavity in the left infraclavicular region (Fig. 7, *A* and *B*). A six-rib thoracoplasty was completed on November 29, 1946, and sputum has remained negative since that time (Fig. 7C). The original cavity in the left infraclavicular region can no longer be identi-

the area over a period of six months supports this view.

CASE VIII. S. C., a male, aged thirty-three, who had a seven-rib thoracoplasty completed in January, 1947, for a large cavity in the right infraclavicular region (Fig. 8A). Sputum has been persistently negative since December, 1946. Planigrams, however, still reveal a small, well defined, radiolucent area measuring about 0.5 cm. in diameter situated just off the right hilum seen clearly on the 7, 8, and 9 cm. levels (Fig. 8, *B* and *C*). It is felt that this is not a residual cavity since it would be almost



FIG. 5. Case v. *A*, admission film showing large cavity in right apex. *B*, Bucky film after seven-rib thoracoplasty. Sputum still positive. Many suspicious highlights are seen in dense right upper lung field. *C* and *D*, planigrams reveal well demarcated radiolucent area in apical portion of right lung which was seen clearly on 6, 7, 8, 9, and 10 cm. levels. It was interpreted as a cavity. The radiolucent area below this is not clearly demarcated, does not correspond in location with any previous cavity and is interpreted as representing normal lung surrounded by dense fibrous strands and thick pleura. Examination of the resected specimen following lobectomy confirmed this interpretation.

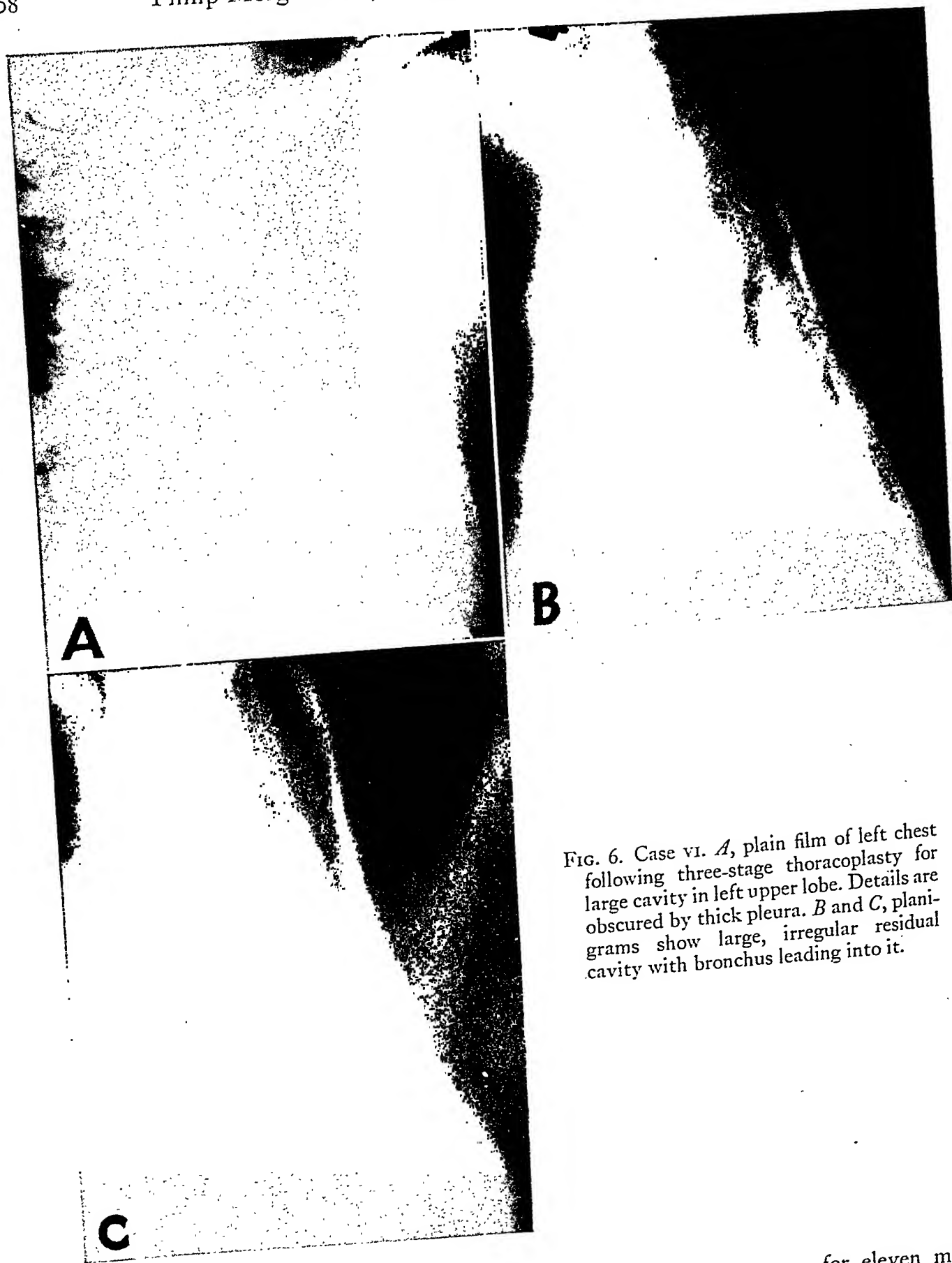


FIG. 6. Case VI. *A*, plain film of left chest following three-stage thoracoplasty for large cavity in left upper lobe. Details are obscured by thick pleura. *B* and *C*, planigrams show large, irregular residual cavity with bronchus leading into it.

impossible for a cavity as small as this to show on three consecutive levels 1 cm. apart. Furthermore, it does not correspond in location with the original cavity which was situated in the axillary portion of the lung field. The per-

sistently negative sputum for eleven months supports this conclusion.

CASE IX. J. D. P., a patient aged twenty-five, with bilateral pulmonary tuberculosis. The



FIG. 7. Case VII. *A*, conventional film showing tuberculous lesion in left upper lobe. *B*, planigram showing definite 2 cm. cavity in left infraclavicular region. *C*, conventional chest film after left thoracoplasty. Patient also has pneumoperitoneum. *D*, planigram shows large radiolucent area in left apex. However, it does not correspond to location of original cavity and probably represents normally aerated lung surrounded by thick pleura and dense fibrous strands. Sputum negative for eleven months.

lesion in the left lung is controlled by pneumothorax. The lesion in the right upper lobe consists of multiple, irregular, caseous areas (Fig. 9*A*). Three sets of planigrams have failed to

demonstrate any definite cavitation (Fig. 9, *B* and *C*). Sputum concentrates, however, are still alternately positive and negative for tubercle bacilli. This is the type of lesion in

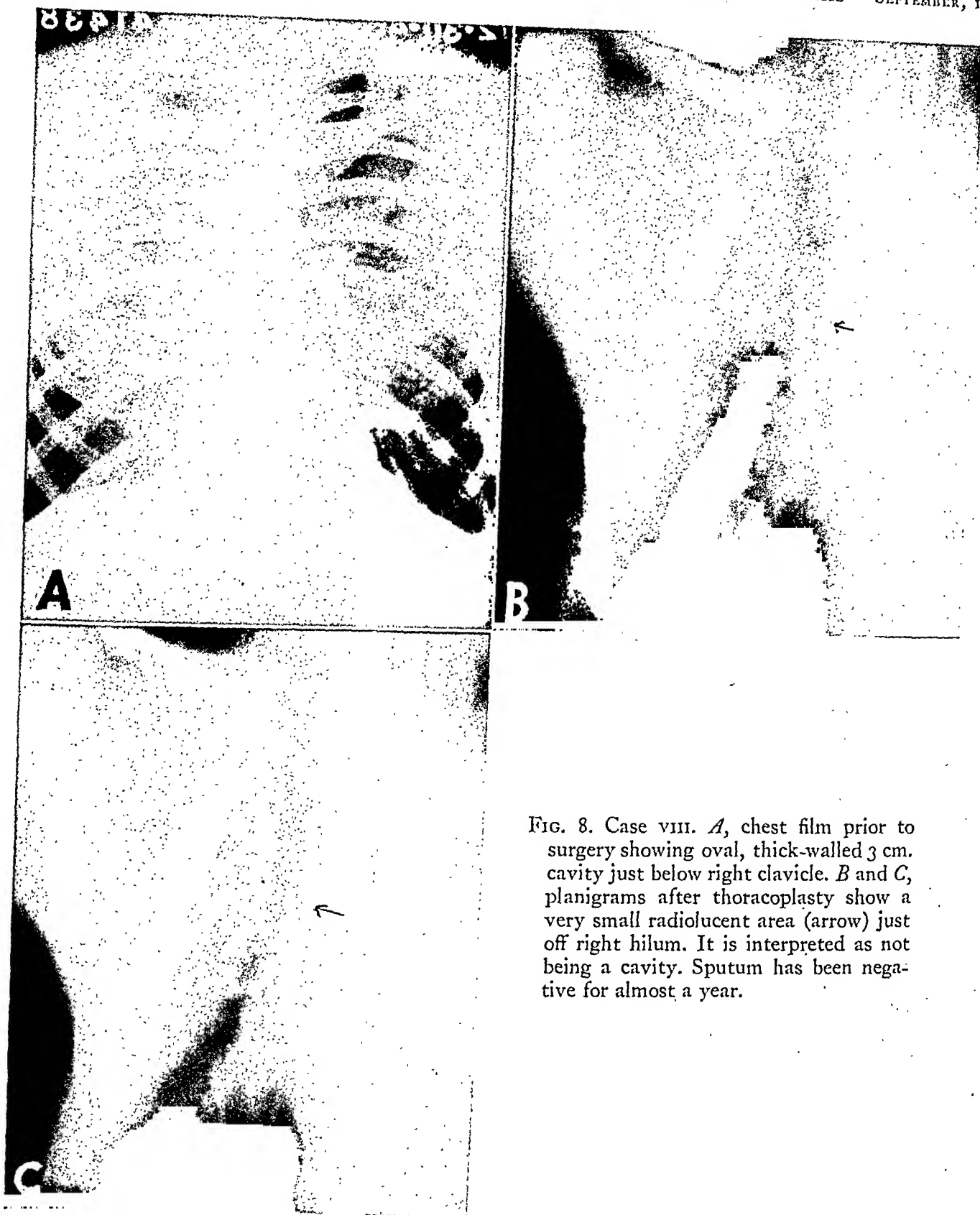


FIG. 8. Case VIII. *A*, chest film prior to surgery showing oval, thick-walled 3 cm. cavity just below right clavicle. *B* and *C*, planigrams after thoracoplasty show a very small radiolucent area (arrow) just off right hilum. It is interpreted as not being a cavity. Sputum has been negative for almost a year.

which we most often get equivocal results. The caseous foci may develop small central areas of liquefaction and discharge their contents into a bronchiole, but the resulting cavities are too small to be seen on the planigram. Sputum at this stage, if positive at all, will usually show tubercle bacilli only on concentrate or culture. Such microscopic or subclinical cavities

may either close spontaneously or else they will enlarge, tubercle bacilli will multiply in the wall of the cavity, communication will be established with a larger bronchus and positive sputum on plain smear will result. In the latter case, the cavity usually becomes clearly visible on the planigram.

CASE X. J. O., a male, aged twenty-three, who had a seven-rib thoracoplasty on the right side in 1945 for a cavity in the right upper lobe (Fig. 10A). A large residual cavity, however, could clearly be seen in the compressed lung (Fig. 10B). Revision operation was done in 1946 with resulting greater compression of the lung and "disappearance" of the residual

and November, 1946, for a dense, fibrocaseous tuberculosis involving the entire right upper lobe (Fig. 11, A and B). Sputum continued positive on concentrate and culture and planigrams showed numerous small, oval, radiolucent areas within the dense, compressed right upper lobe (Fig. 11, C and D). The lung was resected July 29, 1947, and showed exten-

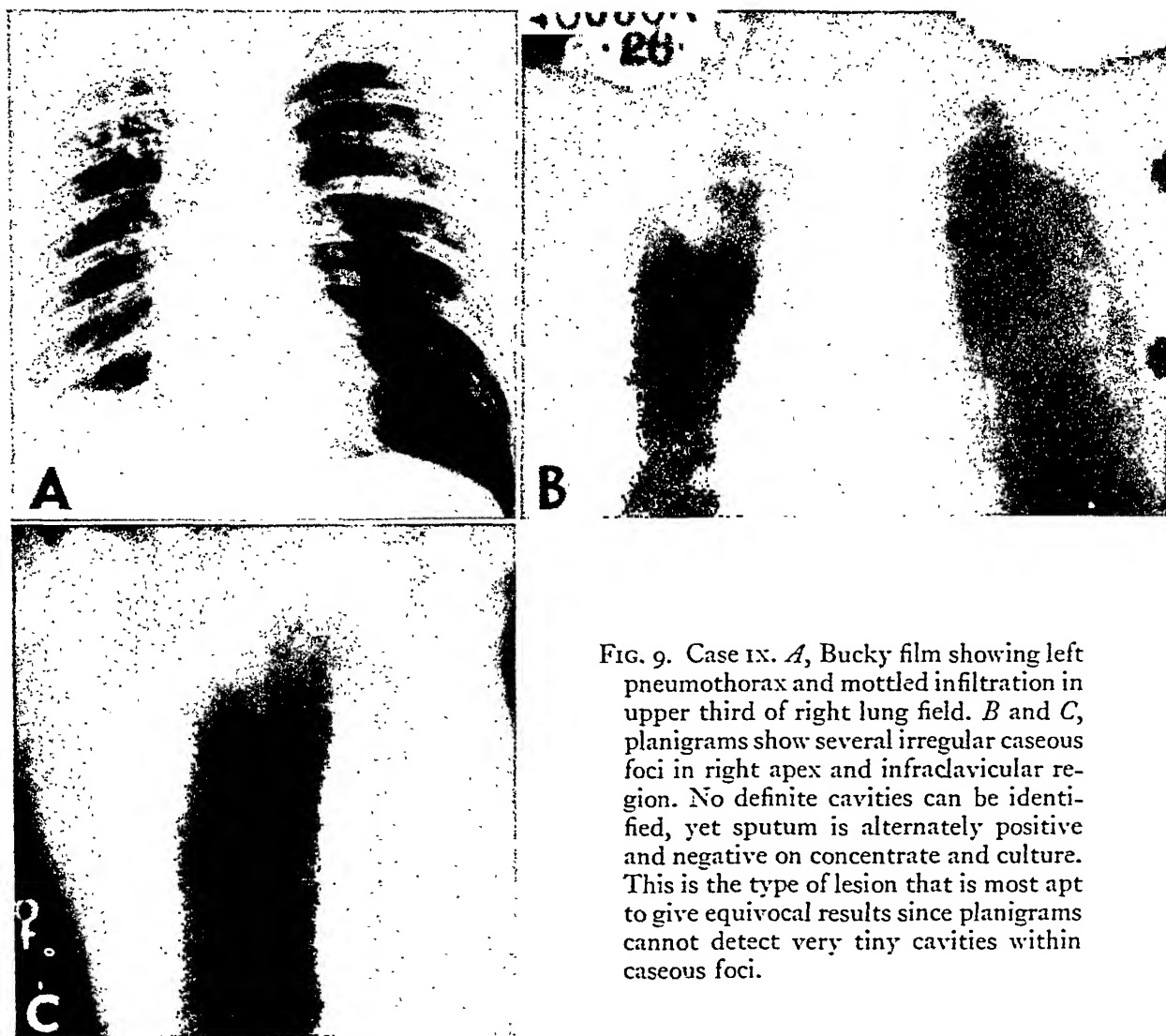


FIG. 9. Case IX. A, Bucky film showing left pneumothorax and mottled infiltration in upper third of right lung field. B and C, planigrams show several irregular caseous foci in right apex and infraclavicular region. No definite cavities can be identified, yet sputum is alternately positive and negative on concentrate and culture. This is the type of lesion that is most apt to give equivocal results since planigrams cannot detect very tiny cavities within caseous foci.

cavity (Fig. 10C). Sputum, however, remained alternately positive and negative. Right pneumonectomy was done in April, 1947, and the resected specimen showed a slit-like cavity measuring 2.5 by 1.5 cm. in the compressed right upper lobe. Such flattened slit-like cavities may not show on the planigram unless some air gains access to the lumen.

CASE XI. J. F., a male, aged twenty-one. A six-rib right thoracoplasty was done in October

sive fibrosis, scattered, small caseous areas and numerous thick-walled, dilated bronchi (Fig. 11E). The latter corresponded with the radiolucent areas seen on the planigrams.

In an extensive, caseous disease which undergoes fibrosis, it may be very difficult to distinguish between small residual cavities and bronchiectatic dilatations.

CASE XII. J. T. C., a white male, aged forty-eight. Onset of his tuberculosis was in 1929.

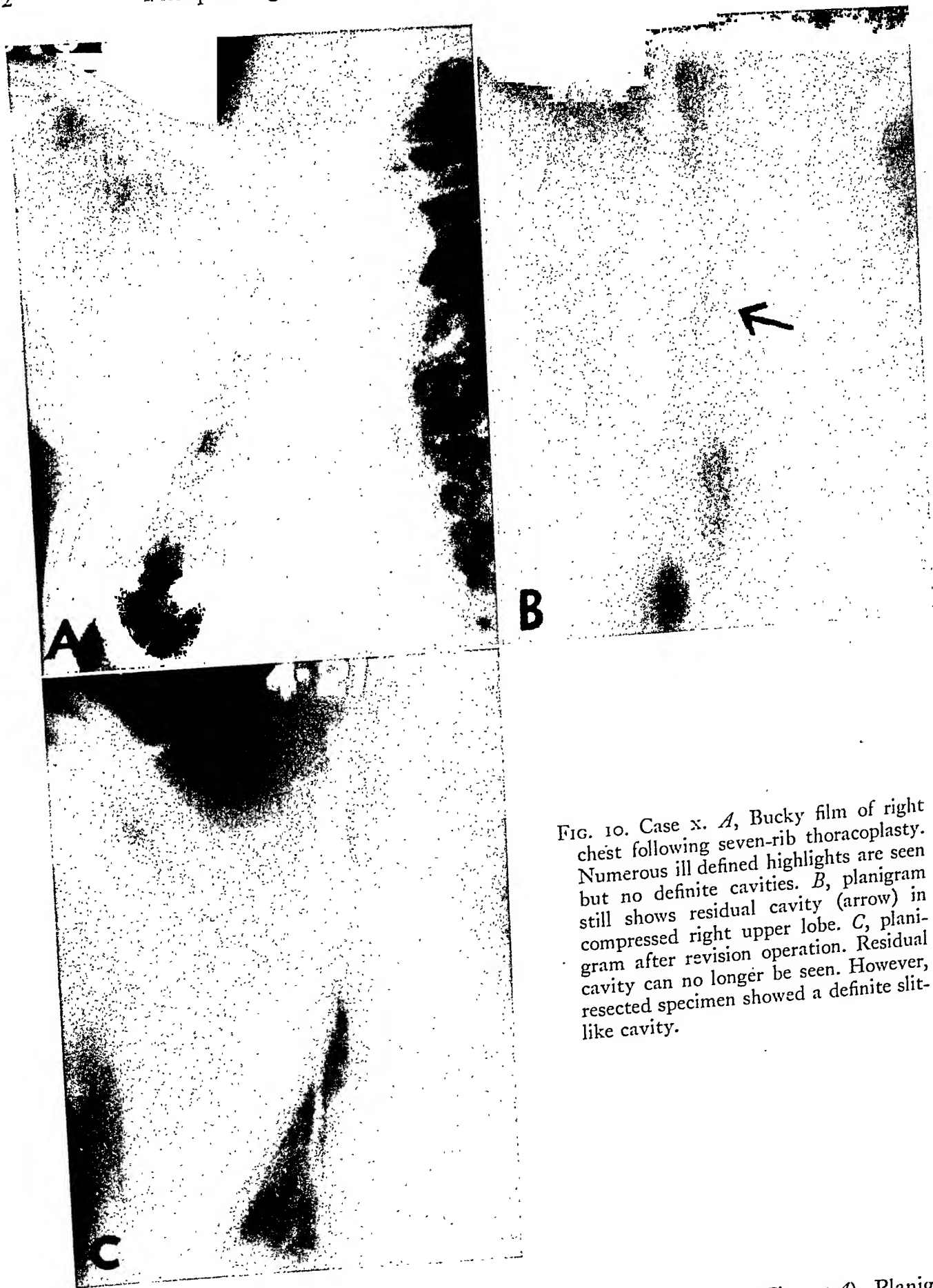


FIG. 10. Case x. *A*, Bucky film of right chest following seven-rib thoracoplasty. Numerous ill defined highlights are seen but no definite cavities. *B*, planigram still shows residual cavity (arrow) in compressed right upper lobe. *C*, planigram after revision operation. Residual cavity can no longer be seen. However, resected specimen showed a definite slit-like cavity.

Conventional chest film shows extensive fibro-calcific deposits in upper third of right lung field with shift of trachea and mediastinum

toward the right side (Fig. 12*A*). Planigrams show two well defined radiolucent areas just beneath the apical pleura on the 5, 6, and 7

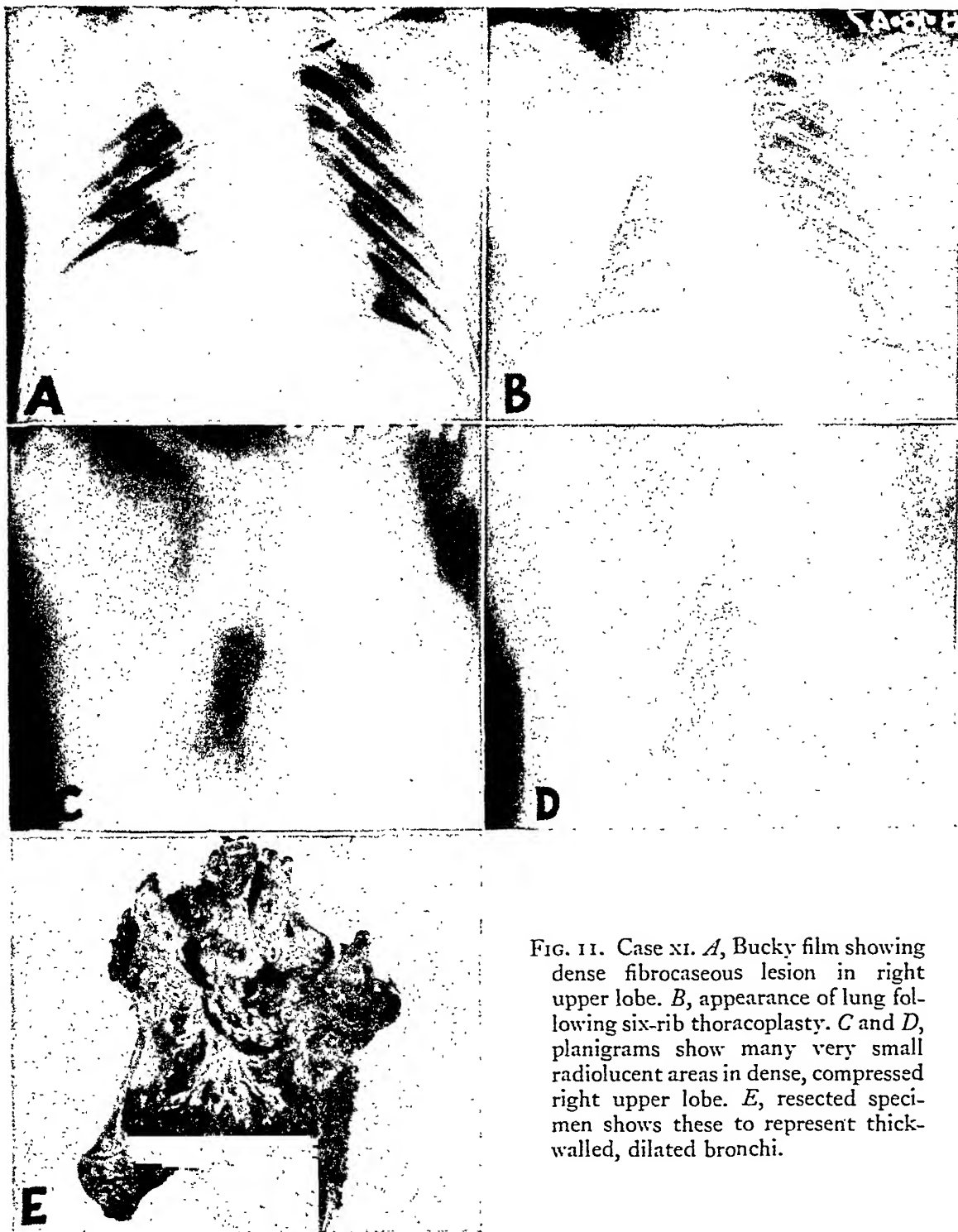


FIG. 11. Case XI. *A*, Bucky film showing dense fibrocaceous lesion in right upper lobe. *B*, appearance of lung following six-rib thoracoplasty. *C* and *D*, planigrams show many very small radiolucent areas in dense, compressed right upper lobe. *E*, resected specimen shows these to represent thick-walled, dilated bronchi.

cm. levels (Fig. 12*B*). Sputum has been persistently negative for tubercle bacilli since 1934. It is felt that these represent emphysematous blebs which are known to be fairly common in this location in cases of long-standing fibrosis.

CASE XIII. F. P., a white male, aged fifty-three, admitted to Oteen in April, 1947, be-

cause of dyspnea and productive cough. Pulmonary tuberculosis was diagnosed in 1921 at which time he had a right thoracotomy for an empyema with bronchopleural fistula. Sputa were all negative for tubercle bacilli at that time and at several subsequent hospital admissions. Plain film showed dense fibrosis in the right apex and infraclavicular region with irregular calcification of the pleura in the right

mid-lung field (Fig. 13*A*). Planigrams revealed several sharply circumscribed, round, radiolucent areas within the dense right upper lung field (Fig. 13*B*). Lipiodol instillation demonstrated saccular bronchiectasis in this region (Fig. 13*C*). The radiolucent areas probably represent areas of emphysema adjacent to

time a roentgenogram showed a fibrocaseous tuberculosis involving the entire right upper lobe with several definite areas of cavitation. Patient has refused any collapse therapy. Over a period of eight years there has been marked fibrosis of the lesion with contraction of the right upper lobe (Fig. 15*A*). However, sputum

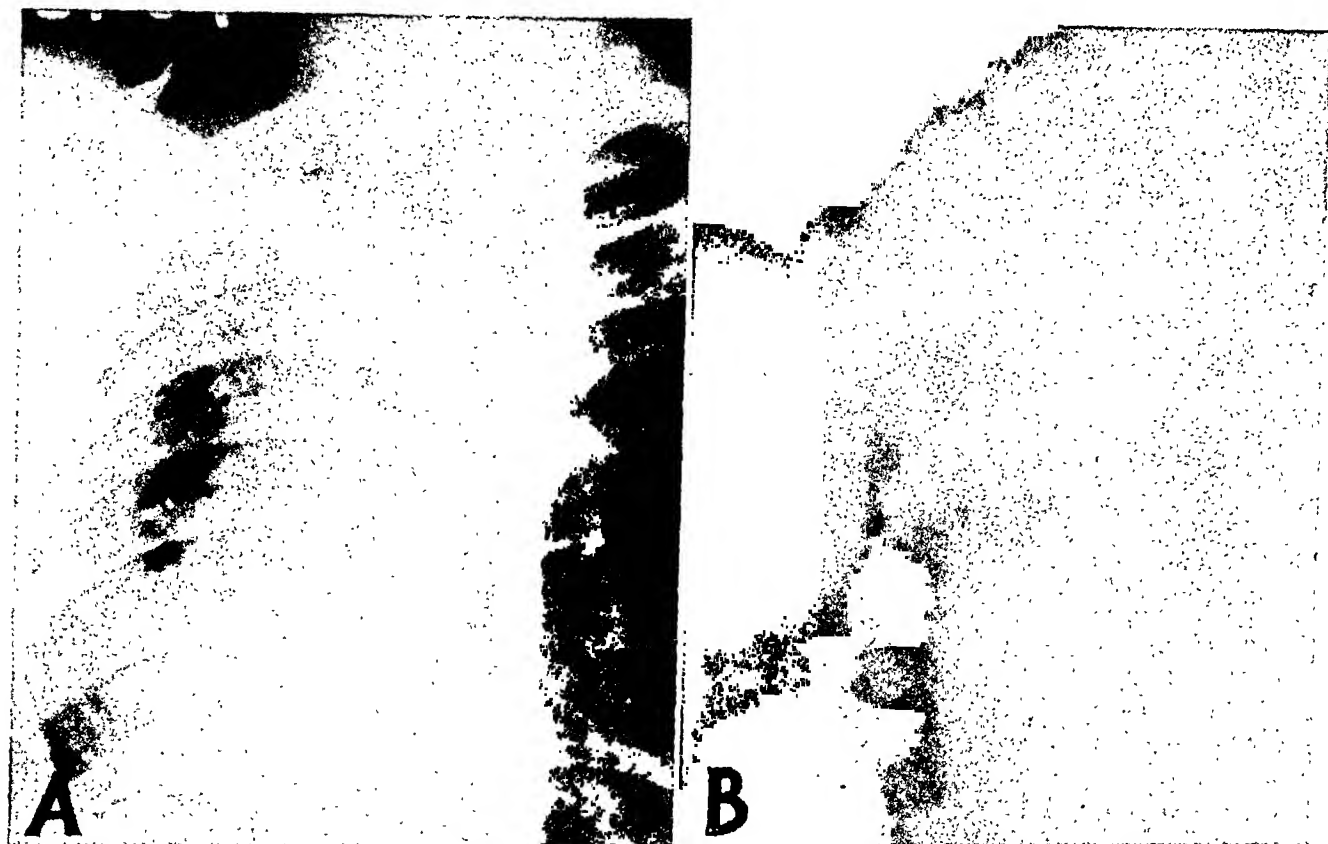


FIG. 12. Case XII. *A*, a case of long-standing tuberculosis. Plain chest film shows extensive fibrocalcific deposits in right lung with several suspicious highlights in right apex. *B*, planigram shows two well defined, radiolucent areas beneath apical pleura. Sputum negative since 1934. They are interpreted as emphysematous blebs.

the bronchiectatic dilatations. The negative sputum since 1921 is the deciding factor in a case like this.

CASE XIV. G. G., a white male, aged fifty-four. Onset of his tuberculosis was in 1923. Conventional film shows dense fibrosis in the left upper lobe with many ill defined highlights (Fig. 14*A*). Planigrams reveal many large, well demarcated, thin-walled radiolucent areas within the fibrotic left upper lobe (Fig. 14*B*). Sputum has been persistently negative since January, 1946. The radiolucent areas are interpreted as areas of emphysema rather than tuberculous cavities.

CASE XV. S. B., a white male, aged fifty. Onset of his tuberculosis was in 1939 at which

is still persistently positive and planigrams show several radiolucent areas which are interpreted as probable cavities (Fig. 15*B*).

This is another case where differentiation between small residual cavities and bronchiectatic dilatations is difficult. The sputum findings are important.

COMMENT

Unfortunately there is no single method of roentgen examination which will accurately diagnose pulmonary cavitation in 100 per cent of cases. We have had considerable experience with Bucky technique and more limited experience with stereoscopic films, and it is our opinion that

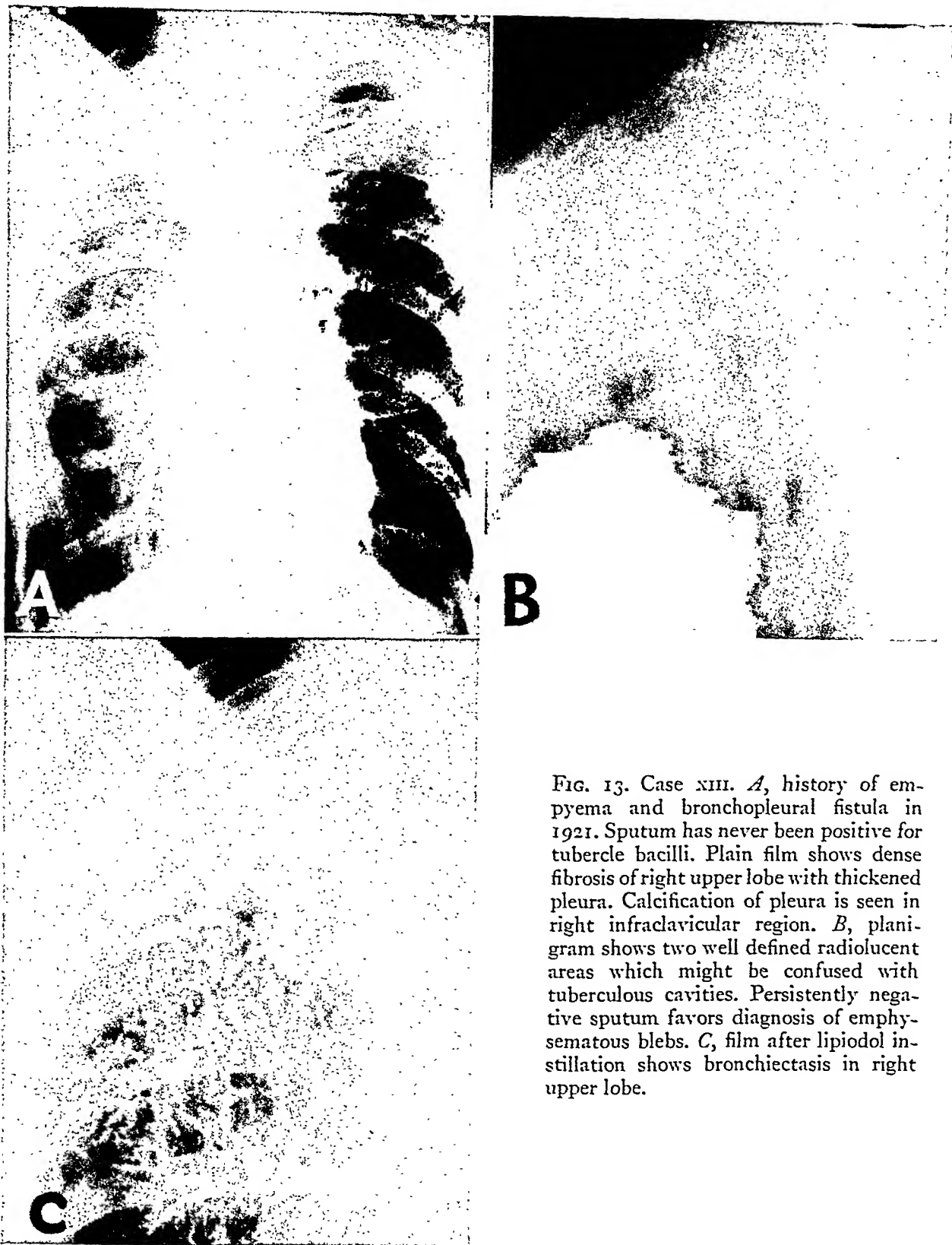


FIG. 13. Case XIII. *A*, history of empyema and bronchopleural fistula in 1921. Sputum has never been positive for tubercle bacilli. Plain film shows dense fibrosis of right upper lobe with thickened pleura. Calcification of pleura is seen in right infraclavicular region. *B*, planigram shows two well defined radiolucent areas which might be confused with tuberculous cavities. Persistently negative sputum favors diagnosis of emphysematous blebs. *C*, film after lipiodol instillation shows bronchiectasis in right upper lobe.

planigraphic examination is superior to either of these methods. This is particularly true in dense caseous lesions or post-thoracoplasty lungs. Considering all types

of tuberculous lesions, planigrams will correctly diagnose the presence or absence of cavitation in about 85 per cent of cases, if the criteria outlined above are used. For

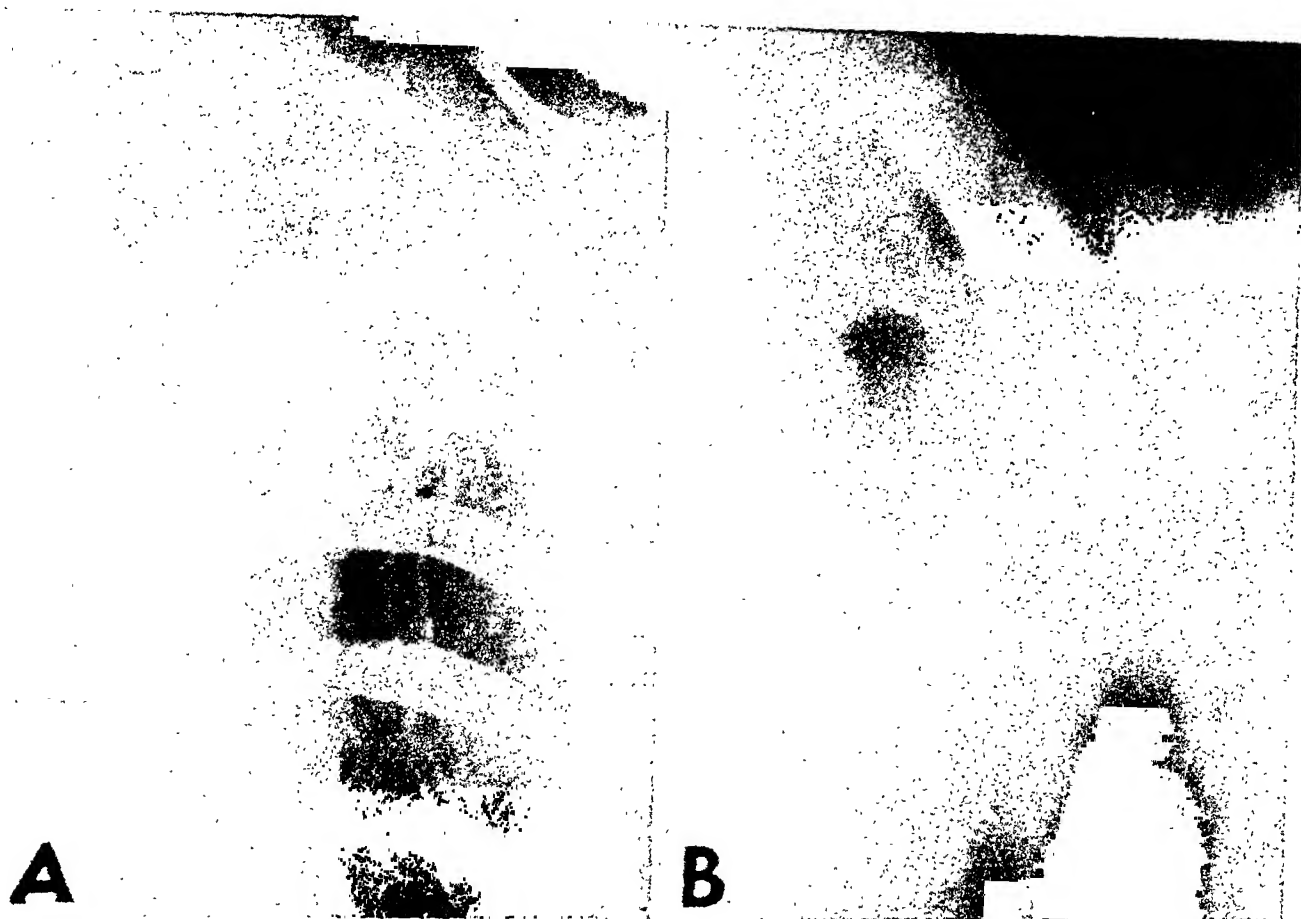


FIG. 14. Case xiv. *A* and *B*, another case showing similarity of emphysematous areas to tuberculous cavities in a fibrotic lung. Sputum in this case has been persistently negative for twenty-two months.

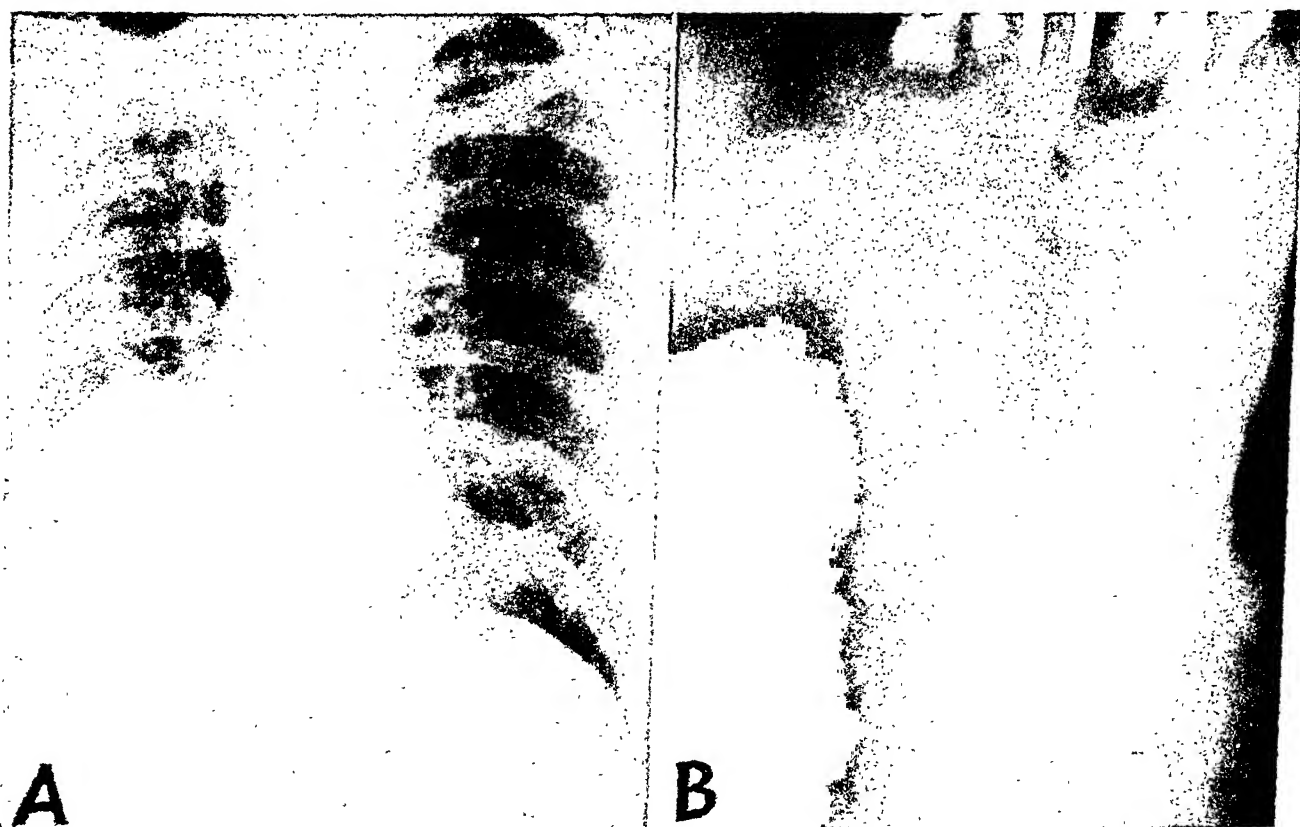


FIG. 15. Case xv. *A* and *B*, persistently positive sputum in a patient with a fibrocaceous lesion of right upper lobe undergoing gradual fibrosis over a period of eight years. Planigrams show many highlights within the shrunken right upper lobe. Final differentiation between tuberculous cavities and bronchiectatic dilations can only be made by sputum studies.

the remaining 15 per cent which are inconclusive, we must rely on roentgenoscopy, sputum studies and clinical findings to make the decision.*

SUMMARY

1. Three hundred sets of planigrams in cases of pulmonary tuberculosis were studied with a view toward more accurately diagnosing cavitation by correlation with clinical and pathological data. Twenty-three cases had pulmonary resection and the roentgen shadows could be checked with the actual lung findings.

2. Certain rigid criteria are outlined for the interpretation of cavitation on planigrams and these are illustrated by case reports.

3. The limitations of planigrams are discussed and some of the pitfalls in diagnosis are indicated. Particular emphasis is placed on emphysematous blebs and bronchiectatic dilatations which may be extremely difficult to distinguish from small tuber-

culous cavities. In such cases the sputum and clinical findings are of the utmost importance in differentiation.

Philip Morgenstern, M.D.
Veterans Administration
Oteen, N. C.

REFERENCES

1. ANDREWS, J. R. Planigraphy; introduction and history. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 36, 575-587.
2. EPSTEIN, I. G., HERMAN, M., GREEN, H., and COHEN, W. Correlation between tomographic studies of lung and necropsy findings. *Quart. Bull., Sea View Hosp.*, 1940, 5, 353-371.
3. GUGGENHEIM, A. Pulmonary emphysema and tuberculosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 58, 64-74.
4. KRAFT, E., and HERMAN, M. Tomographic diagnosis of pulmonary cavities; evaluation of pulley system with 77 cases. *Quart. Bull., Sea View Hosp.*, 1940, 5, 279-301.
5. MOORE, S. Practical applications of body section roentgenography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 44, 24-30.
6. MOORE, S. Chapter on Body Section Radiography. In: *Diagnostic Roentgenology*. Ross Golden, Editor. Thomas Nelson & Sons, New York, 1947, Vol. II, pp. 1123-1141.
7. WEIDMAN, W. H., and KIEFFER, J. Laminagraphy in chest conditions. *Am. Rev. Tuberc.*, 1941, 53, 202-212.

* Since the submission of this paper for publication we have examined an additional 27 cases whose films could be correlated with resected lung specimens. Our conclusions were essentially the same as those reached in our paper.



THE SYNDROME OF ARTERIOVENOUS FISTULA OF THE LUNG

By PETER CRANE, M.D., HENRY H. LERNER, M.D., and EDWIN A. LAWRENCE, M.D.

THE presence in the lung of an abnormal communication between an artery and a vein produces a clinical syndrome consisting of cyanosis, clubbing of the fingers and toes, bruit, and polycythemia.

The literature is extremely sparse in its reference to vascular tumors in the lung. There are twenty-four sporadic reports up to September, 1947, referring to 26 cases of vascular anomalies or new vascular growths in the lung with related clinical symptoms. It is interesting that in the last twelve months alone 8 new cases have been reported. A few others have been diagnosed but not reported, while many are not recognized. One of us (H. H. L.) has seen 3 surgically proved cases in the past three years.

It is quite probable that patients presenting these findings are mistakenly considered to be suffering from an incurable cardiac anomaly. Many instances of tumors of the lung masquerade under the stigma of congenital heart disease. The difficulty in making the correct clinical diagnosis might be overcome if the roentgenological and clinical features of the syndrome were more widely known. Attention should be called to the possibility of a vascular anomaly of the lung in any patient with unexplained polycythemia and associated symptoms due to disturbed oxygenation of the blood.

DEFINITION AND NOMENCLATURE

The abnormal vascular communication in the lung has been designated by a variety of terms. Similar terms have been used to describe different pathological conditions. Conversely a single pathological condition has been designated by different names. The nomenclature of the vascular tumors as reported in the literature is unsatisfactory because of the scarcity of adequate pathological descriptions.

In this category is an early group of 9

cases diagnosed at autopsy (Table 1). The terms used include: Case 1—"capillary hemangioma." Case 2—"capillary type of malignant hemangioma." Case 3—"cavernous sinus spaces with cellular malignant areas." Case 4—"hemangioma." Case 5—(not recorded). Cases 6 and 7—"capillary angioma." Case 8—"cavernous hemangioma." Case 9—"closed hemangioma."

In a later group of 7 cases 4 (11, 13, 19, 22) were not proved either by operation or autopsy so that the final diagnosis cannot be recorded. In the remaining 13 cases the following terms were used: Case 10—"multiple hemangioma." Case 12—"cavernous hemangioma." Case 14—"cavernous hemangioma." Case 15—"arteriovenous fistula." Case 16—"multiple arteriovenous fistulae." Case 17—"cavernous hemangioma." Case 18—"arteriovenous aneurysm associated with congenital abnormalities of the pulmonary vessels." Case 20—"hemangioma." Case 21—"hemangioma." Case 23—"cavernous angioma." Case 24—"pulmonary arteriovenous fistula." Case 25—"pulmonary aneurysm." Case 26—"varicose vessels and sinuses."

When blood flows directly from an artery to a vein through widened vascular channels without an intermediate capillary bed the short circuit is referred to by some authors as an "arteriovenous aneurysm." This term is used by other authors as synonymous with "arteriovenous fistula". A distinction should be made between the two terms. An "arteriovenous fistula" is a direct shunt between an artery and a vein without the interposition of capillaries. An "arteriovenous aneurysm" is the result of a simultaneous rupture of an artery and a vein with the blood from both being poured out into the cellular tissues which forms a communication or "false aneurysm" between them.

In this paper we are including those cases in which a shunt exists between the arterial and venous systems of the pulmonary circulation. The case we are reporting we prefer to call an "arteriovenous fistula".

HISTORICAL

Rodes²⁰ may be credited as the first to correlate the clinical picture with the

had marked attacks of wheezing with groaning and cyanosis. Hall¹⁰ reported a case with multiple cavernous sinus spaces in the lungs showing cellular malignant areas. Bowers⁴ reported an autopsy on a two day old male infant with numerous hemangiomata of the lung.

Following Rodes' report nineteen other papers have appeared reporting one or

TABLE I
INCOMPLETE CASES

Case No.	Author	Sex	Age	Cyanosis	Dyspnea	Pathology
1	de Lange and de Vries-Robles 1923—autopsy	F	2½ mo.			Capillary hemangioma
2	Wollstein 1931—autopsy	F	4	Yes	Yes	Capillary hemangioma (malignant)
3	Hall 1935—autopsy	F	40 yr.	Terminally		Cavernous sinus spaces (malignant)
4	Bowers 1936—autopsy	M	2 days		Yes	Hemangioma
5	Duvoir <i>et al.</i> 1939—autopsy		12 yr.		Yes	
6	Plaut 1940—autopsy	F	35	Slight		Capillary angioma
7	Plaut 1940—autopsy	F	53			Capillary angioma
8	Verse 1943—autopsy	M	Infant		Sudden	Cavernous hemangioma
9	Verse 1943—autopsy	F	30			Closed hemangioma

pathological findings in the lung. His recognition and description of this syndrome was based on the postmortem examination of a patient who during life had manifested symptoms attributable to a vascular shunt. At autopsy "multiple multilocular hemangiomas" were found in the lungs.

Prior to the paper of Rodes in 1938 there were only four references in the literature dealing with vascular tumors of the lung. These were all necropsy reports. Plaut¹⁸ states that de Lange and de Vries-Robles¹⁴ in 1923 mention the first recorded autopsy case of "multiple capillary angiomas" of the lung. Wollstein²⁴ reported what she called a "capillary type of malignant hemangioma" in a four month old infant who

more instances and bringing the total number of cases to 26. Duvoir *et al.*⁷ performed a necropsy on a twelve year old child who had multiple visceral angiomas, one being in the lung. Plaut's¹⁸ report of 2 autopsies mentions "capillary angioma." Verse²³ reported 2 autopsied cases. One was in a male infant who had "multiple cavernous hemangiomas" of the left lung. The second was in a female who had a "closed hemangioma" of the lung. She was known to have had "heart disease" for a period of at least three years.

The 4 cases appearing prior to Rodes' report and the 5 cases noted in the preceding paragraph have such meager clinical and laboratory data that they could not be in-

cluded in our statistical analysis. Their salient features are therefore outlined in Table 1.

Rodes' paper, which was the first to correlate the clinical with the pathological findings, was based on the autopsy of a twenty-five year old male with multiple multilocular hemangiomas in both lungs. The patient died of a massive pulmonary hemorrhage. The first clinical diagnosis of an arteriovenous fistula was made by Smith and Horton.²² They reported a case of a forty year old male in whom they were able to demonstrate an arteriovenous fistula of the lung by means of angiocardiology. They were unable to obtain pathological proof of their diagnosis. Hepburn and Dauphinee¹¹ must be credited with the first case diagnosed clinically and proved at surgery. They reported a twenty-three year old female who had an hemangioma in the upper part of the right lower lobe of the lung. This was diagnosed as a "sinus cavernous angioma" and confirmed by pneumonectomy. Goldman⁸ reported a case of a twenty-two year old male who was clinically diagnosed as having a "cavernous hemangioma" of the left midlung field. In this report he gives a complete description of the clinical syndrome and the diagnostic roentgenologic criteria. He mentions the presence of a large vascular tumor mass in the lung parenchyma from which large blood vessels lead to the hilum of the lung. Janes¹² reported a thirty year old male diagnosed as having cavernous hemangiomas of the right and left lung fields and proved by surgery. Jones and Thompson¹³ reported a twenty-four year old female with varicosities of the right upper lobe and an arteriovenous fistula demonstrated at operation and by specimen. Adams *et al.*¹ reported a twenty-four year old male in whom a pneumonectomy was done for a multilocular smooth-lined cavity with arteriovenous connections or arteriovenous fistulae. Alexander² reported the autopsy findings in a forty-one year old male with cavernous hemangiomas which connected directly with the pulmonary vessels. Sis-

son, Murphy and Newman²¹ reported a case of a forty-five year old female who had arteriovenous aneurysms in the right and left lower lung fields. These were diagnosed as arteriovenous fistulae by angiocardiology and proved at autopsy. Lindren¹⁵ reported 3 cases of arteriovenous fistula. The first was in a thirty year old male who had an arteriovenous communication in the region of the left interlobar fissure. The second was in a twenty-nine year old male who had hemangiomas in the right and left lung fields. The third was in a twenty-five year old female who had four vessels leading to a large tumor in the left lingula. Angiocardiology with lobectomy was performed in the latter two. The first case had no pathological confirmation. Makler and Zion¹⁶ reported a case of multiple pulmonary hemangiomas in a twenty year old male. Surgical proof of an arteriovenous fistulae was not available. Goldman⁹ reported 2 cases of arteriovenous fistulae in brothers and pointed out that it may be familial. (One of these might be the case reported in 1943.) Beierwaltes and Byron³ reported a single case of an arteriovenous aneurysm. Burchell and Clagett⁶ reported a case of an arteriovenous fistula complicated by collateral circulation and cured by lobectomy.

The case reported in this paper was diagnosed clinically and roentgenologically prior to surgery. Angiocardiology and surgery demonstrated the lesion to be vascular in nature. Histopathological examination proved it to be an arteriovenous fistula.

CASE REPORT

Present Illness. This fifty year old white male, railroad shop worker, had a routine pre-employment physical examination and chest roentgenogram about November 24, 1946. At that time he was told that he had a large tumor of the right lung and was advised to consult his physician.

He had always been well. There was no history of cough, hemoptysis, weight loss or fever. On rare occasions he had noted constricting pain lasting about one or two minutes, radiating from the middle of the right chest

across to the right side. These pains were not related to exertion, the intake of food, or any unusual position of the body. They did not radiate to the arms, back or neck. The last episode of pain occurred one and one-half months previous to entry into hospital.

Physical Examination. General: Well-nourished, middle-aged, white male, in no distress. Feet and hands are visibly cyanotic. Head: Normal in contour. No irregularities, scars or tumors. Eyes: Small pterygium, left. Ears: Hearing appears normal. No discharge. Nose: Septum straight. No obstruction. Throat: Pharynx granular. Neck: Thyroid not palpable. No pulsations. Cardiovascular: Blood pressure 110/70. Dull to percussion anteriorly below the fifth right rib, with decreased breath sounds and vocal fremitus. There is a very loud systolic bruit over this area. Few dry crackling rales at both bases posteriorly. Chest: Expansion is free and equal. Resonance and fremitus not increased or diminished. Vesicular breath sounds heard throughout. No rales. Expiration not prolonged. Gastrointestinal: Mouth—teeth carious and dirty with marked pyorrhea. Abdomen: Soft. No masses, rigidity, or tenderness. Liver, spleen and kidneys are not palpable. No hernias. Appendectomy scar. Rectum: No induration, hemorrhoids, fissures or fistulas. Genitourinary: Discrete, rubbery, nontender, translucent 3 cm. mass at upper pole left testicle. Neuropsychiatric: Mentally clear. No tremors. Superficial and deep reflexes are present and active. Babinski and Romberg signs negative. No clonus. Skin and Mucous Membranes: Lips and mucous membranes cyanotic. Numerous small petechiae on lower legs. Extremities: Slight clubbing of fingers and toes. Moderate varicosities on both legs. No ankle edema. Bones and Joints: Spine is straight and flexible. No pain on motion or percussion.

Diagnosis: (1) Hemangioma of right lung, right middle lobe. (2) Hydrocele, left. (3) Chronic sinusitis. (4) Pyorrhea.

Operative Report: (Doctor E. Lawrence). A curvilinear incision was made over the right chest following the fourth rib. Periosteum was reflected with a periosteal elevator and the rib removed from its sternal junction posteriorly to near its vertebral origin. Pleura was then opened and the tumor in the right middle lobe exposed. The right upper and middle lobes were then removed as follows: Sharp dissection was used to isolate the branches of the pulmo-

nary arteries and vein. These were then doubly ligated, transfixed, and cut. The right upper and middle bronchi were then exposed and severed near their origin. The open proximal ends were then closed with interrupted silk sutures. Hemostasis was obtained by clamp and ligature, and the thoracic cavity washed out with normal saline. A No. 24 French catheter was then sutured to the parietal pleura and brought out through the wound for closed drainage. Two hundred thousand units of penicillin was placed in the pleura cavity. Pleura was then closed. Muscles and skin were closed with interrupted silk. The thoracic cavity was then aspirated of all air with a syringe in order to reinflate right lower lobe.

Pathological Report: Gross: This specimen consists of the upper and middle lobes of a right lung, amputated at the hilum. The interlobar fissure is obliterated by dense, old, fibrous adhesions in its ventral one-third. In its dorsal two-thirds there are delicate fibrous adhesions between the two lobes. The upper lobe measures about 15 by 11 by 6 cm. The middle lobe measures about 12 by 7 by 5.5 cm. Much of the lower lobe is occupied by a bulging cystic tumor which borders upon the interlobar fissure, extending to within about 3 cm. of the ventral margin and about 2 cm. of the posterior border. The surface of the cyst bulges prominently on the lateral surface of the lower lobe and its wall is so thin that in places it is transparent. On its superior surface the cyst encroaches slightly upon the parenchyma of the upper lobe, compressing it. On the medial surface there is a smooth elevation, apparently consisting of atelectatic lung which is compressed by the medial surface of the cyst. The pleura of the subapical portion of the lung on its dorsal surface is thickened and unevenly hemorrhagic. Numerous small fibrous tags are attached to the pleural surface in this portion over an area which measures about 8 by 5.5 cm. in diameter and located principally on the posterior and posterolateral surface of the upper lobe. Elsewhere the pleura is thin, transparent and slightly wrinkled. It is unevenly mottled and streaked with black pigment. The peribronchial lymph nodes at the hilum are not appreciably enlarged; they are firm and black. The larger vessels at the hilum are ligated with surgical sutures.

A vertical section taken through the center of the bulbous protuberance of the lateral surface

of the middle lobe reveals a mass of firmly clotted blood which completely fills the cavity. That portion of the lining of the cavity which lies against pulmonary tissue is unevenly mottled and streaked with yellowish patches, some of which contain calcific deposits. One of these atheroma-like plaques is slightly ulcerated. The opening of the artery is in the superior portion of the lateral wall of the cyst. The diameter of the artery as it enters the cavity is 7 by 5 mm. Near the hilum of the lung the artery reaches a maximal circumference of 23 mm. The lumen of the vein is larger than that of the artery. At its entrance into the aneurysmal sac it is approximately 1 cm. in diameter, and about 0.8 cm. in diameter near the hilum of the lung at the site of amputation. The intima of the artery shows very slight atheromatosis. That of the vein is essentially normal. The principal diameters of the aneurysmal sac are approximately 6.5 by 6.5 by 6 cm. At the hilum of the middle lobe the principal bronchus measures 0.8 cm. in diameter and its lumen is completely obstructed by a plug of inspissated mucus. The parenchyma in the ventral margin and in the inferior margin below the aneurysmal sac is indurated and apparently completely airless. It appears to have been greatly compressed by the cyst-like aneurysmal sac.

Microscopic: Section A—Taken through hilum of lung and including the artery: The wall of the artery shows no significant degree of degenerative disease until it reaches its expanded portion in the wall of the aneurysmal sac. On one side the smooth muscle wall continues as far as the area represented by the section but shows infiltrates of lymphocytes around the blood vessels of the adventitia and in the inner portion of the media. On the other side the muscular wall ends abruptly and is replaced by a wall of fibrous tissue with only occasional small bundles of smooth muscle. The large bronchus at the hilum is collapsed and its epithelium is missing from a large portion of the mucosa. No significant degree of inflammatory reaction is evident. The pulmonary parenchyma is partially atelectatic but otherwise not remarkable.

Section B—Elastic fiber stain of the same tissue: The arterial wall is composed almost entirely of collagenous tissue and smooth muscle. Only traces of elastic fibers are seen in the wall.

Section C—Section through the thin (lateral)

portion of the aneurysmal sac: The wall contains smooth muscle and hyalinized fibrous tissue. The intima is unevenly thickened and in one place there is a calcified atheromatous plaque. Small bronchioles and alveoli are compressed against the wall of the sac.

Section D—In a section stained for elastic fibers no elastic tissue is found.

Sections E and F—Section through wall of aneurysm and pulmonary parenchyma of the medial side of the sac (hematoxylin and eosin and elastic fiber stains): The intima is unevenly thickened and elevated in the form of atheromatous plaques. In one area the media also appears to be degenerated and the collagenous fibers are separated. There is no ulceration and only one small focus of calcification is present in this section. The parenchyma which surrounds the sac is compressed and the air spaces are partly filled with edematous fluid and blood. Small foci of lymphocytic infiltration are located in the outer zone of the wall of the aneurysm.

Diagnosis: Arteriovenous "aneurysm" of the middle lobe of the right lung. Atheromatous degeneration with slight calcification of the wall of the aneurysm. Compression atelectasis, especially of the middle lobe of the lung.

ANALYSIS OF CASES (INCLUDING PRESENT REPORT) (TABLE II)

Sex. Of the 27 cases, the sex was not mentioned in one. Fifteen were males and 11 females.

Location. In 5 instances the site of the tumor was not mentioned. In 5 cases the right lung and in 7 the left lung was involved. In 10 of the patients both lungs were involved with one or more vascular tumors.

CLINICAL FINDINGS (TABLE II)

The analysis of the clinical findings is based on only 18 of the 27 cases. These were the only ones with sufficient clinical data to warrant inclusion and to distinguish them as an entity.

Cyanosis. Cyanosis was present in all of the 18 cases. Though a constant finding in this syndrome it varied in intensity from severe to minimal. In some patients it was noted as being transient, in others as constant.

TABLE II
CLINICAL FINDINGS

Case No.	Authors	Sex	Age yr.	Cyanosis	Clubbing	Dyspnea	Vascular Anomalies	Bruit	Chest Pain	Hemoptysis	Enlarged Heart	Weakness	Dizziness	Faintness	Fatigue	Headache	Convulsions	Numbness	Epistaxis	Thick Speech
10	Rodes 1938—autopsy	M	25	+	+	+	+		+	+	o			+			+			
11	Smith and Horton 1939—angiogram	M	40	+	+	+		+	+		o	+	+	+				+		
12	Hepburn and Dauphinee 1942—pneumectomy	F	23	+	+	+	o	o					+	+						+
13	Goldman 1943—clin. diag.	M	22	+	+	+	+	o	+		o	+				+				
14	Janes 1943-44—resection	M	30	+			+	+		+					+					
15	Jones and Thompson 1944—pneumectomy	F	24	+	+			+			o									
16	Adams <i>et al.</i> 1944—pneumectomy	M	24	+	+		+				o								+	
17	Alexander 1945—autopsy	M	41	+	+	+		+			+		+							
18	Sisson <i>et al.</i> 1945—angiogram and autopsy	F	45	+	+	+	+	+	+	+	+	+	+	+	+		+	+		+
19	Lindgren 1946—clin. diag.	M	30	+	+	+		+	+		+	+			+	+				
20	Lindgren 1946—lobectomy and angiogram	M	29	+	+	+	+	+		+	o						+	+		
21	Lindgren 1946—lobectomy and angiogram	F	25	+	+	+		+		+	o			+	+					
22	Makler and Zion 1946—clinical	M	20	+	+	+	+	+			o					+			+	
23	Goldman 1947—pneumectomy	M	22	+	+															
24	Goldman 1947—no report	M	32	+	+															
25	Bierewaltes <i>et al.</i> 1947—lobectomy	F	27	+	+	+	+				o			+				+	+	
26	Burchell and Clagett 1947—pneumectomy	M	20	+	+	o	+	+	o	o	o	o		o	o		o	o	o	o
27	Crane <i>et al.</i> 1947—lobectomy	M	45	+	+	+	+	+	+	o	o	o	o	o	o	o	o	o	o	o

Dyspnea. Dyspnea was recorded in 13 cases and not mentioned in 5. It was variable in its onset, constancy or degree of incapacity.

Clubbing of Digits. This was mentioned as

being found in all cases except 2 in which no statement was made as to whether or not it was present. The degree of the clubbing could not be determined from the records. Both fingers and toes were involved. Its

disappearance after surgery was noted in 1 case. In another it was still present months after removal of the fistula.

Bruit. An audible bruit was present in 11 cases. It was definitely indicated as not being present in 2 cases. Its presence or absence was not mentioned in 5 cases. The phase during which the bruit was heard was inconstant.

Visible Associated Vascular Anomalies. This was recorded as being present in 9 instances and as not being present in 1 case. These consisted of external hemangiomas, varices and local telangiectasis. In 8 instances no reference was made.

Chest Pain. Chest pain was recorded as being present in 6 instances. It was usually sharp in nature, radiating and transient. In 11 cases it was not mentioned.

Hemoptysis. This was noted in 5 cases. (In Case 10 it was recorded as being fatal.) Small amounts of blood in the sputum was the most frequent manifestation. It was mentioned as definitely not being present in 1 instance. In 11 cases it was not mentioned at all.

Cardiac Enlargement. It was present in 3 cases. One of these (Case 17) died of coronary occlusion, a second had hypertension (Case 18) and a third (Case 19) had some form of clinical valvular disease. It was definitely recorded as not being present in 11 instances. In 3 cases there was no mention of the heart size. It is apparent that cardiac enlargement such as may occur with traumatic or congenital arteriovenous aneurysm of the peripheral circulation is not prominent in this syndrome.

Lungs. In 5 instances the records show that there was evidence of "consolidation" or dullness over the tumor site. Nine cases were reported as "clear."

Weakness and Dizziness were reported as being present in 5 cases.

Fatigue was prominent in 4 instances and *headache* was noted in 4 cases.

Convulsions occurred in 3 cases. In 1 case the patient had transient terminal convulsions (Case 18), in another (Case 20) it was noted that the patient had "some"

convulsions, and the third (Case 10) had convulsions many years before the diagnosis of arteriovenous fistula was made.

Transient numbness was reported as occurring in 4 cases, at times related to body position.

Epistaxis was noted in 3 cases.

Thick speech was recorded in 2 instances.

COMPOSITE CLINICAL PICTURE

The clinical picture is quite characteristic and could well be labelled a syndrome. The characteristic findings common to almost all of the cases were cyanosis, dyspnea, clubbing of the digits, and thoracic bruit. The associated findings of visible vascular anomalies, chest pain, hemoptysis, absence of cardiac enlargement, weakness, dizziness, faintness and fatigue occurred with sufficient frequency to warrant their inclusion in the syndrome.

ROENTGEN FINDINGS (TABLE III)

In all 18 cases a definite statement was made of a tumor in the lung demonstrated roentgenologically. Rodes was the first to describe the roentgen findings in the lungs. The illustration in his paper is typical of an arteriovenous fistula. Smith and Horton were the first to achieve the angiographic demonstration of an arteriovenous fistula in the lung.

Multiple tumors were frequently noted. In Case 14 two were present in the right lung and one or possibly two in the left. Case 17 showed lesions in both the left and in the right lung field. Case 20 had a mass present in the right lung and two in the left. In Case 22 three shadows were present in the right and one in the left lung field.

In Case 10 the roentgenogram is not described. It is stated in the paper that there was a mass in the left lower lung field. Examination of the print in that article reveals the presence of a large, poorly delineated vascular shadow leading from the left hilum to a mass in the lung. This probably represents a dilated artery and

TABLE III
ROENTGEN AND PATHOLOGICAL FINDINGS

Case No.	Location of Lesion	Pathological Findings	Roentgen Findings
10	Rt. posterior and lt. upper lobe	Multilocular multiple hemangiomas	Mass in the lt. lower lung field; dense bands to the hilum
11	Rt. base posteriorly	Probably arteriovenous fistula	Two dilated vessels arising in rt. hilum and communicating in parenchyma of rt. lung
12	Right lower lobe	Cavernous sinuses and cavernous angioma	Infiltration in the right middle and lower lobe
13	Left mid-lung field	Cavernous hemangioma	Pulsating mass
14	Rt. lower and middle lt. lower	Cavernous hemangioma	Two shadows in the rt. lung. One, possibly two, in the left
15	Right middle lobe	Varicosities over rt. upper lobe and A-V fistula	Mass in the rt. lower lung with a large vessel from the hilum
16	Three in left lung	Multilocular smooth lined cavities with A-V connections. Multiple A-V fistula	Moderately opaque areas
17	Lt. base, one large. Many small tumors in rt. and lt. lungs	Cavernous hemangioma. Direct connection with pulmonary vessels	Large round opacity at lt. base post. and a small one at rt. base. Vessels seen going to tumor
18	Both rt. and lt. lungs	Arteriovenous aneurysm	Round opaque area, well defined borders. No pulsation
19	Lt. interlobar fissure	A-V communication	Round density in lt. base. Broad density from it to hilum
20	Superior lobe on right	Hemangiomas	Irregular round formation in rt. interlobar septum. Two vessels lead to the hilum. Two similar shadows on lt. No pulsation
21	Lingula	Hemangioma	Irregular density connected to the hilum
22	Right and left	Pulmonary hemangioma	Opacities mid portion of rt. lung field. Vessels to the hilum
23	Lt. hilum lt. mid-lung field	Cavernous angioma	Mass in the left hilum and lt. lung
24	Left mid-lung	Pulmonary arteriovenous fistula	Mass in the left mid-lung
25	Left lower lobe	Pulmonary aneurysm	3 cm. area with pulsation. A tail-like projection to hilum
26	Right middle lobe	No communication between the artery and vein. Varicose vessels with vascular sinuses	Irregular pulsating. Nodular shadow in right lung
27	Right middle lobe	Arteriovenous fistula	Opaque shadow in right mid-lung field

vein leading to and from the arteriovenous fistula.

In Case 11 the roentgenogram was described as showing infiltration at the base of the right lung which was thought to be the result of bronchiectasis. Angiography demonstrated two dilated vessels communicating in the right lung. In Case 12 the roentgenogram was described as revealing an infiltrative process in the right

middle and lower lobes which was shown by lipiodol injection not to be bronchiectatic. A second interpretation of other roentgenograms was given as "vascular endothelioma." The final diagnosis was noted as "pulmonary fibrosis." At a third examination it was felt that an abnormal arteriovenous communication on the order of a cavernous hemangioma was present.

In Case 13 the roentgenograms were

interpreted as showing a zone of homogeneous opacity which had an intrinsic pulsation synchronous with the pulsation of the pulmonary artery as demonstrated by kymography.

In Case 14 the roentgenograms showed two shadows in the right lung and one in the left. The diagnosis rested between multiple hemangiomas and adenomas of the lung.

In Case 15 the roentgenoscopic examination was interpreted as showing the right

venous aneurysm or congenital heart disease.

In Case 17 the roentgenograms were interpreted as showing large rounded opacities at the left and right base. The diagnosis was emphysema and chronic bronchitis.

In Case 18 the roentgenograms showed a large opaque area in the left lung. Roentgenoscopically the mass did not pulsate. Bronchograms failed to reveal any communication with the bronchial tree. An

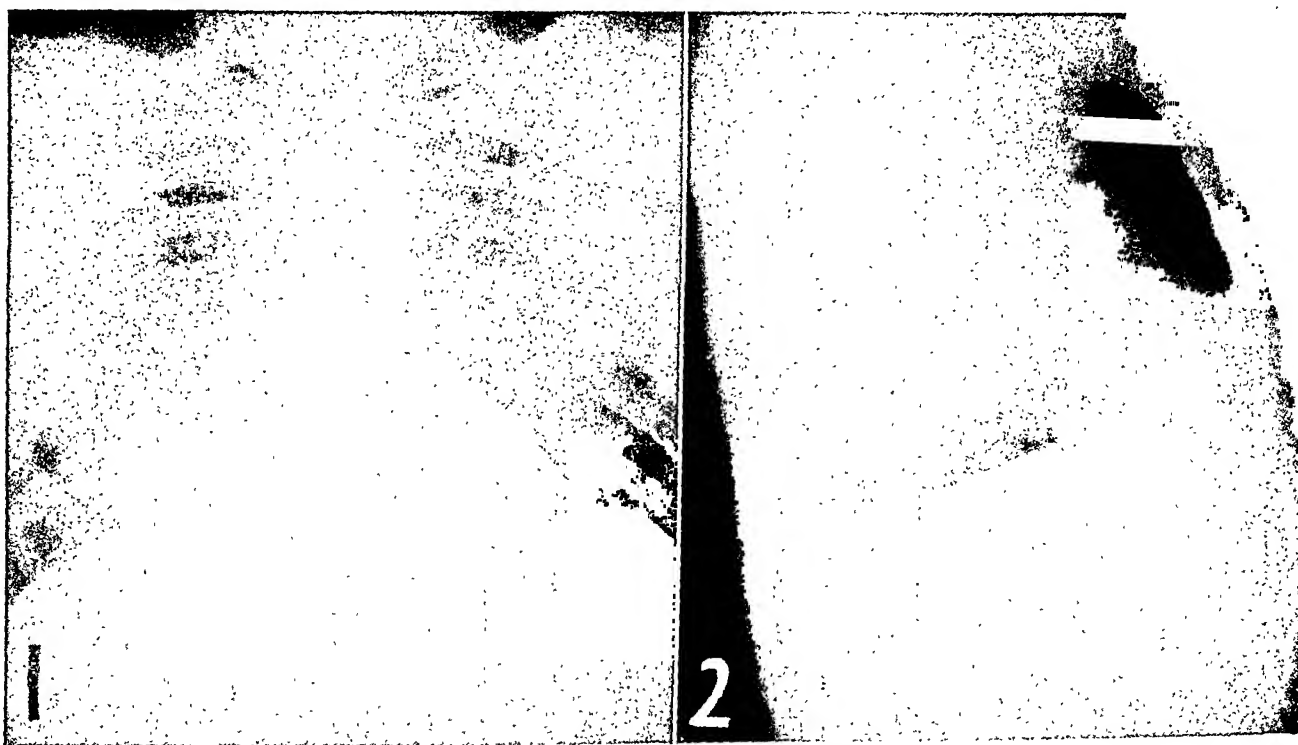


FIG. 1 and 2. Oval soft tissue tumor mass lying in region of right middle lobe. Right hilum extends lower than normal and communicates with soft tissue mass by two widened vascular shadows. Pulsation of vessels seen on roentgenoscopy.

hilum to be increased in density and containing a pulsating vessel radiating to a round mass 8 by 10 cm. in diameter. Body section roentgenograms demonstrated these to be vessels leading to a pulsating vascular mass in the lung. The vessels appeared to be composed of dilated branches of the pulmonary artery.

In Case 16 roentgenograms showed a lobulated moderately opaque area 25 cm. square and a second smaller area. The roentgen diagnosis was pulmonary fibrosis or arteriovenous shunt through an arterio-

angiogram with a catheter in the right auricle was reported to have been done. No other statement was added.

In Case 19 an irregular rounded density was connected by broad sinuous densities to the vessels of the hilar region. It was diagnosed as an arteriovenous aneurysm. Roentgenoscopic examination failed to reveal any abnormal pulsations.

Case 20 showed the right lung to contain an irregular rounded formation connected with the hilum by a broad-shaped density of sinuous vessels. The left lung in this

same case showed two similar formations. Each of the rounded densities led to sinuous vessels that were wider than adjacent vessels and whose course deviated from other vessels. On the Valsalva test the volume of mass in the lung diminished. On the Müller test it increased. On roentgenoscopy the vessels did not pulsate. The diagnosis was arteriovenous aneurysm.



FIG. 3. Angiogram. Film taken two seconds after injection of diodrast. Tumor opacified. Vessel leading to it (artery) also opacified. Vein noted as fainter shadow.

In Case 21 there was an irregular density connected to the hilar region by broad-shaped densities which seemed to merge into the vessels of the latter. On the Valsalva and Müller tests there was respectively a decrease and an increase in size of the tumor shadow. On angiocardigraphy the contrast medium passed through the vessels and the densities became more dense. The diagnosis was arteriovenous aneurysm.

In Case 22 the description was that of a discrete opacity in the right lung and a less well defined irregular opacity in the left lung. From each of these opacities a broad linear shadow extended to the hilum.

The patient was followed for a period of eight months during which no change appeared. Three years later, however, the patient was roentgenographed again and two new masses were noted in the lower right lung field. The Valsalva test showed a decrease and the Müller test showed an increase in the size of the masses. Pulsations could not be demonstrated roentgeno-

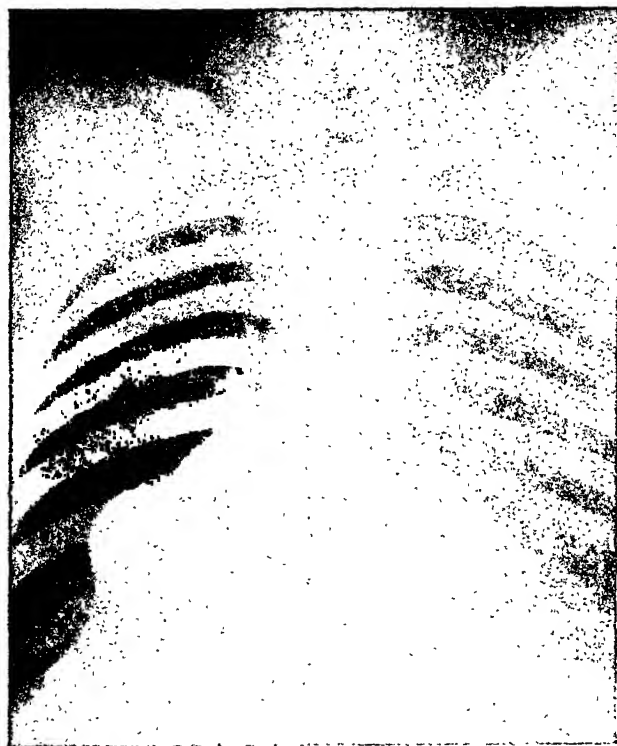


FIG. 4. Angiogram. Film taken four seconds after injection. Tumor further opacified. Vessel to it (artery) less dense. Vessels in parenchyma of lung filled with opaque medium.

scopically. Laminagraphy showed the vessels to be dilated pulsating arteries. The lung field masses showed an irregular worm-like configuration. The diagnosis was multiple pulmonary hemangiomas.

Case 23 showed in the roentgenogram a mass in the left hilum and left lung. Nothing is mentioned of vascular changes.

In Case 24 there was a mass in the left mid-lung.

Case 25 showed a 3 cm. area in the right lower lung field that pulsated. Leading from this to the hilum was a tail-like projection.

In Case 26 there was an irregular nodular

shadow in the right lung which pulsed during roentgenoscopic observation.

The case being reported (Case 27) showed a large soft tissue tumor mass which lay in the region of the right middle lobe (Fig. 1 and 2). Leading from the hilum to this mass were two large parallel vessels of different densities. The inferior vessel was much more dense than the superior one. During roentgenoscopic examination both vessels were noted to pulsate, the lower one more markedly than the upper. During the Valsalva test there was a definite decrease in the size of these vessels. During the Müller test they increased in size and density.

Angiocardiography demonstrated that these vessels and the tumor shadow communicated directly with the pulmonary vessels. As the opaque material left the main pulmonary artery the lower vessel and the tumor mass became markedly opacified (Fig. 3). As the tumor mass emptied of the opaque media the upper vessel and the smaller pulmonic vessels in the lung parenchyma became more visible due to increased opacification (Fig. 4). The diagnosis of an arteriovenous fistula was thus confirmed.

COMPOSITE ROENTGEN FINDINGS

A review of the prints of the roentgenograms in the literature plus an analysis of the reports enables us to describe the characteristic roentgen appearance of an arteriovenous fistula in the lung.

This consists primarily of a round, smooth, soft tissue tumor mass usually in the lower lung field. The hilum of the involved side appears denser than the uninvolved one due to the added vascular bed. Arising from the hilum and converging on the soft tissue mass in the parenchyma, there are usually present two large sinuous blood vessels. One of these will show definite pulsations synchronous with the pulmonary artery. This probably represents a pulmonic artery. The other, the vein, will show minimal to no pulsation. The pulsation may be demonstrated on roent-

genoscopy or a permanent record obtained by kymography. The vascular nature of the tumor mass can be demonstrated by means of angiography. This technique lends itself admirably to the visualization of the normal pulmonary circulation and any aberrations present. The independent filling of the pulmonary arterial and venous systems can be demonstrated by taking serial films. The phase of opacification of the vessels leading to the tumor mass indicates which is the artery and which is the vein. Opacification of the tumor mass itself labels it as a vascular lesion.

There are other valuable maneuvers which can be used to substantiate the diagnosis. The Valsalva test in which increased intrathoracic pressure prevents the flow of blood into the pulmonary bed causes the vascular tumor and its vessels to decrease in size. In the opposite or Müller test in which the intrathoracic pressure is decreased and a negative force exerted, the tumor and its vessels increase in size. Catheterization of the heart and the right pulmonary vein with analysis of blood samples for oxygen content should also offer diagnostic data. Procedures of negative value such as bronchoscopy, bronchography and pneumothorax, may be used to demonstrate that the tumor mass is not related to the bronchial tree.

LABORATORY DATA—TABLE IV—(GROUP OF EIGHTEEN CASES)

Hemoglobin. The values are given in some instances as grams of hemoglobin or percentage of normal or as in Case 14 as "normal" without any figure. In Case 21 no mention was made of the hemoglobin value. Of the cases in which reports are available all showed an increase in hemoglobin ranging between 108 per cent (Case 10) and 138 per cent (Case 13) hemoglobin, or 19.5 grams (Case 22) and 32.7 grams of hemoglobin (Case 11).

Several cases show variation in the hemoglobin values which should be noted. Case 14 was reported as normal. The patient, as expected, had no clinical findings which

could be correlated with decreased blood oxygenation. Case 19 was recorded as having 55 per cent of hemoglobin for which there is no explanation. Case 18 was recorded as having 14.5 grams of hemo-

21 the red blood count was not mentioned. Case 14 was recorded as having a normal count with microcytosis and hypochromia.

Hematocrit. The hematocrit was recorded in only 8 cases. The values ranged from 82

TABLE IV
LABORATORY DATA

Case No.	Author	Hemoglobin	R.B.C.	Hematocrit	W.B.C.	Platelets	Blood Volume cc.	Plasma Volume cc.	Volume of Cells cc.
10	Rodes	108%	7.54		9,800				
		118%			10,700				
11	Smith and Horton	20.6 gm.	6.47	66	3,200	104,000	6,068	760	
		32.7 gm.			7,300				
12	Hepburn and Dauphinee	12.2 gm.	9.6	80			8,500		
		21.8 gm.					3,500		
13	Goldman	137%	11.45		4,100	855,000	8,170	2,450	5,720
14	Janes	Marked microcytosis and hypochromia			11,400				
15	Jones and Thompson	130%	6.5		7,350	Normal			
			7.5						
16	Adams, Thornton and Eichelberger	23 gm.	7.2		6,600		12,750	2,420	10,330
	Postoperative	17.0 gm.	4.94	63	12,300		4,970	2,280	2,690
			6.04		7,000		6,900	2,920	4,350
17	Alexander	20.4 gm.	8.2		5,100				
			2.5		7,600				
18	Sisson <i>et al.</i>	14.5 gm.			9,120				
19	Lindgren	55%	4.3						
20	Lindgren	125%	6.48						
21	Lindgren					175,000			
22	Makler and Zion	19.5 gm.	7.7	55	6,500				
23	Goldman		11						
24	Goldman		7						
25	Beierwaltes and Byron	21.6 gm.	8.2	75		7,000			
26	Burchell and Clagett	24.1 gm.	7.59	82			11,716	2,516	9,180
27	Crane, Lerner and Lawrence	19.5 gm.	6.2	64	6,200				
	Postoperative	15.9 gm.	5.59	50	7,500		5,535	3,010	

globin. This patient had both acute renal and cardiac disease as well as multiple episodes of hemoptysis any of which could have produced the anemia.

Red Blood Cell Counts. The counts ranged between a maximum value of 11.45 million (Case 13) and 6.2 million red blood cells per cubic centimeter (Case 23). The case with 55 per cent hemoglobin (Case 19) had a red blood count of 4.3 million. Case 18 with 14.5 grams of hemoglobin did not have a red blood count recorded. In Case

preoperative in Case 24 to 64 in Case 26. Following surgery there was a rapid return to normal.

White Blood Cell Count. The white blood cell count was in no instance significantly elevated. This is an important differential point inasmuch as in true polycythemia there is a leukocytosis. In 4 cases the count was not recorded. Two cases were reported as having counts of 3,200 (Case 11) and 4,700 (Case 13). In the remaining cases the values ranged between 6,500 and 11,400.

TABLE V
BLOOD OXYGEN VALUES

Case No.	Oxygen Capacity		Oxygen Content		Per Cent Saturation		Venous Oxygen Content	
	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative
12					70-75			
13	27.4		16.7		70		9.5	
16	35.54	20 24.7	25.1	17.87	71	72.95	22.5 (63% unsat.)	14.8 (14-33% unsat.)
19	13.8		12.5		89.9			
25					77	92.2		
26	30.8	14.8 (15 days) 20.2 (10 wk.)	22.8	13.7 (15 days) 19.0 (10 wk.)	74	92 (15 days) 98 (10 wk.)		
27	25.54	19.42	23.07	17.7	90.3 (normal is 95%)	91.1	9.98	

Platelets. In the 4 cases in which there is a record the values were recorded as 104,000 (Case 11), 855,000 (Case 13), 175,000 (Case 21), normal (Case 15).

Blood Oxygen Values. These were only reported in a few cases (see Table v).

Incidental Reports. Circulation time, electrocardiographic findings, vital capacity, pulse rate and blood pressure were all normal.

DISCUSSION

The presence of an arteriovenous fistula provides a shunt in the lung so that a portion of the blood is unoxygenated. This produces a demand for increased red blood cell production, i.e. a secondary polycythemia. The mechanism of the erythrocytosis is assumed to be the low oxygen saturation of the arterial blood, either acting directly on the bone marrow or by way of some by-product of asphyxia. In the absence of erythrocytosis evidence of anoxia may occur in the form of cyanosis, dyspnea and syncope. In contrast to polycythemia vera the white blood cell count is not elevated nor is the spleen enlarged. The typical syndrome of cyanosis, dyspnea, clubbing of the digits, plus a bruit, associ-

ated with secondary polycythemia due to an arteriovenous shunt in the lung can easily be mistaken for congenital heart disease.

The increasing number of reports in the literature of arteriovenous fistulas of the lung indicates that this entity has in the past been overlooked. The excellent results achieved by the thoracic surgeon in the correction of this condition now affords these patients a chance for normal living.

SUMMARY

A case of an arteriovenous fistula of the lung is reported. The characteristic clinical, laboratory and roentgen findings based on an analysis of the available literature are noted.

Henry H. Lerner, M.D.
314 Commonwealth Ave.
Boston, Mass.

REFERENCES

1. ADAMS, W. E., THORNTON, T. F., JR., and EICHELBERGER, L. Cavernous hemangioma of lung (arteriovenous fistula); report of case with successful treatment by pneumonectomy. *Arch. Surg.*, 1944, 49, 51-58.
2. ALEXANDER, W. S. Haemangioma of the lung;

- report of case showing polycythaemia. *New Zealand M. J.*, 1945, 44, 180-182.
3. BEIERWALTES, W. H., and BYRON, F. X. Pulmonary arteriovenous aneurysm with secondary polycythemia. *J.A.M.A.*, 1947, 134, 1069-1072.
 4. BOWERS, W. F. Rupture of visceral hemangioma as cause of death, with report of case of pulmonary hemangioma. *Nebraska M. J.*, 1936, 21, 55-57.
 5. BREA, M. M., and NINO, F. L. Hemangioendelioma del pulmón. *Bol. d. Inst. clín. quir.*, 1943, 19, 265-272.
 6. BURCHELL, H. B., and CLAGETT, O. T. Clinical syndrome associated with pulmonary arteriovenous fistulas, including a case report of a surgical cure. *Am. Heart J.*, 1947, 34, 151-162.
 7. DUVOIR, M., PICOT, G., POLLET, L., and GAULTIER, M. Angiome du poumon. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1939, 55, 596-602.
 8. GOLDMAN, A. Cavernous hemangioma of the lung: secondary polycythemia; case report. *Dis. of Chest*, 1943, 9, 479-486.
 9. GOLDMAN, A. Pulmonary arteriovenous fistula with secondary polycythemia occurring in two brothers. *J. Lab. & Clin. Med.*, 1947, 32, 330-331.
 10. HALL, E. M. Malignant hemangioma of the lung with multiple metastases. *Am. J. Path.*, 1935, 11, 343-352.
 11. HEPBURN, J., and DAUPHINEE, J. A. Successful removal of hemangioma of the lung followed by disappearance of polycythemia. *Am. J. M. Sc.*, 1942, 204, 681-685.
 12. JANES, R. M. Multiple cavernous haemangiomas of the lungs successfully treated by local resection of tumours. *Brit. J. Surg.*, 1944, 31, 270-272.
 13. JONES, J. C., and THOMPSON, W. P. Arteriovenous fistula of the lung; report of patient cured by pneumonectomy. *J. Thoracic Surg.*, 1944, 13, 357-373.
 14. DE LANGE and DE VRIES-ROBLES. *Ztschr. f. Kinderh.*, 1923, 34, 304. Quoted by Hepburn and Dauphinee.¹¹
 15. LINDGREN, E. Roentgen diagnosis of arteriovenous aneurysm of lung. *Acta radiol.*, 1946, 27, 585-600.
 16. MAKLER, P. T., and ZION, D. Multiple pulmonary hemangiomata. *Am. J. M. Sc.*, 1946, 211, 261-266.
 17. MARTENS, G. Ueber multiple Cavernome der Pleura. *Frankfurt. Ztschr. f. Path.*, 1923, 44, 272-276.
 18. PLAUT, A. Hemangioendothelioma of the lung; report of 2 cases. *Arch. Path.*, 1940, 29, 517-529.
 19. RANKL, W. Hemangioma of the lung. *Beitr. z. path. Anat. u. z. allg. Path.*, 1942, 106, 316-321.
 20. RODES, C. B. Cavernous hemangiomas of lung with secondary polycythemia. *J.A.M.A.*, 1938, 110, 1914-1915.
 21. SISSON, J. H., MURPHY, G. E., and NEWMAN, E. V. Multiple congenital arteriovenous aneurysms in pulmonary circulation. *Bull. Johns Hopkins Hosp.*, 1945, 76, 93-111.
 22. SMITH, H. L., and HORTON, B. T. Arteriovenous fistula of the lung associated with polycythemia vera; report of case in which diagnosis was made clinically. *Am. Heart J.*, 1939, 18, 589-592.
 23. VERSE, M. Hemangioma of the lung and pleura. *Deutsche Ztschr. f. Chir.*, 1943, 257, 684.
 24. WOLLSTEIN, M. Malignant hemangioma of the lung with multiple visceral foci. *Arch. Path.*, 1931, 12, 562-571.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. *Foreign Collaborators:* GÖSTA FORSSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San Jose, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.; *Secretary:* H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio.

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fiftieth Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949.

AMERICAN RADIUM SOCIETY

President: Maurice Lenz, New York, N. Y.;
President-Elect: William S. MacComb, New York, N. Y.; *1st Vice-President:* Leland R. Cowan, Salt Lake City, Utah; *2nd Vice-President:* James A. Corscaden, New York, N. Y.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: William E. Costolow, Chairman, Los Angeles, Calif., Charles L. Martin, Dallas, Texas, A. N. Arneson, St. Louis, Mo.

Program Committee: William S. MacComb, Chairman, New York, N. Y., James F. Nolan, Los Angeles, Calif., John E. Wirth, Baltimore, Md., John V. Blady, Philadelphia, Pa.

Publication Committee: Edward H. Skinner, Chairman, Kansas City Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Research and Standardization Committee: Robert B. Taft, Chairman, Charleston, S. C., Jacob R. Freid, New York, N. Y., K. W. Stenstrom, Minneapolis, Minn.

Education and Publication Committee: James A. Corscaden, Chairman, New York, George C. Andrews, New York, A. N. Arneson, St. Louis, Mo.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: E. P. Pendergrass, Chairman, Philadelphia, Pa., John F. Hynes, Wilmington, Del., P. C. Swenson, Philadelphia, Pa.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., J. E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: 1950, to be announced.

EDITORIALS

MINERAL OIL PNEUMONITIS

DURING routine photofluorographic examinations of the chest not infrequently obscure lesions of the lungs are encountered which constitute a challenge to the diagnostic ingenuity of the investigator. Perhaps the most interesting of these lesions is a silent circumscribed shadow accidentally discovered in one of the lower lobes of a healthy appearing elderly person. Although the roentgen findings are not altogether typical and bronchoscopic biopsy proves negative for malignancy, usually a clinical diagnosis of cancer of the lung is made and lobectomy or pneumonectomy recommended. Then at operation, surprisingly, a pneumonitis is found.

Schneider¹ recently called attention to the fact that the habitual use of mineral oil for constipation has a very definite role in the production of such lesions. During a tuberculosis case-finding survey of two years he picked up seven cases of pneumonitis which were due to taking of liquid petrolatum as a laxative for many years. Based on these cases and by reviewing the literature dealing with oil aspiration pneumonitis, he established the salient features which characterize this disease.

The ingested mineral oil enters the lungs through overspilling into the larynx. Schneider found that in most cases this overspilling is due to absence or diminution of the gag reflex. However, the liquid petrolatum is so bland that, especially in older persons, it may pass from the nasopharynx into the larynx even when the neurologic examination is entirely negative. The repeated deposition of very small quantities of the oil in the lower bronchi provokes, after a considerable period of

time, a persisting local reaction eventually leading to a demonstrable opacity in the roentgenograms. Once the pneumonitis has appeared, it will continue to slowly advance as long as the patient takes the oil laxative.

It has been known for some time that in patients with defective swallowing, whether due to an interfering organic lesion, or a nervous dysphagia or simply to extreme debility, mineral oil as a habitual laxative leads not infrequently to lipid pneumonitis. There are several reports published from large institutions caring for the mentally ill, aged and chronically sick emphasizing this fact and cautioning against the administration of oil laxatives in such patients. Likewise, the danger of producing aspiration pneumonitis from oil medication in nose and throat conditions, especially in children, has been repeatedly stressed. Other authors described the harmful effect that may result in the lungs from the prolonged use of oily nose drops or oily nasal sprays. What makes Schneider's observation of particular interest is the fact that he now reports that oil aspiration pneumonitis also occurs in apparently healthy persons addicted to the habitual use of mineral oil who exhibit very few or no clinical symptoms.

A study of the pathogenesis of lipid pneumonitis shows that various oils act in a different manner. Saponifiable animal oils which contain large amounts of fatty acids (or lead, when in contact with the tissue enzymes, to formation of fatty acids) produce severe immediate reactions upon entering the lungs. The saponifiable vegetable oils commonly used as vehicles for other drugs or as the carriers of opaque media produce no immediate reaction but may lead to pulmonary changes after a very prolonged use. The liquid petrolatum, or mineral oil, is a non-saponifiable oil and

¹ Schneider, Louis. Pulmonary hazard of the ingestion of mineral oil in the apparently healthy adult. *New England J. Med.*, 1940, 240, 284-291.

therefore behaves as an inert foreign body. After repeated aspirations the accumulation of the oil in the alveoli of the lungs sets in motion a process which is dominated by phagocytic phenomena first and by fibrotic changes later.

The distribution of mineral oil pneumonitis follows the law of gravity of the descending free fluid. Since most patients are ambulatory adults, the most frequent site of involvement is the base of the right lung. Occasionally the lesion may be located in the base of the left lung and in the long protracted cases, as a rule, both sides become affected.

Clinically, the most striking features of mineral oil pneumonitis are the paucity of symptoms and the disproportion between the remarkably good general condition of the patient and the advanced degree of pulmonary involvement. All the cases of Schneider were discovered accidentally. Sometimes the examined person complained of a slight dry hacking cough and of some shortness of breath on exertion, but at an advanced age such symptoms could easily be attributed to arteriosclerotic heart disease.

Regarding the roentgen appearance of mineral oil pneumonitis, Schneider states that in the earliest cases no localized findings or only increased markings in the affected area may be present. Later, a small, circumscribed opacity is found, usually resembling a bronchopneumonic focus. When marked proliferative reaction constitutes part of the histopathologic process the opacity may appear quite dense, giving an image not unlike that observed in primary carcinoma of the lung. With further advance of the lesion, the bronchopneumonic infiltrations may fuse into "an ill defined area of ground-glass density" and the involvement may become bilateral. Not infrequently, recurring acute pneumonitis may be superimposed on the very slowly progressing chronic process.

The diagnosis of mineral oil pneumonitis, if all the facts are known, is relatively simple. A differentiation from basal tuberculosis, primary bronchiectasis and my-

cotic infections, as a rule, encounters no difficulty. The unilateral solitary form may erroneously be diagnosed as primary carcinoma of the lung. However, the peripheral extension, the absence of pressure atelectasis and the lack of metastatic involvement of the hilar glands are valuable signs supporting the diagnosis of mineral oil pneumonitis.

Schneider also stresses the importance of two confirmatory tests. One of these consists in the examination of the sputum for oil droplets. The patient is asked to discontinue taking mineral oil and after several days the morning sputum is collected for three successive days in a wide-mouthed jar which is kept in a refrigerator. By placing cigarette paper or a piece of lens paper on the surface of the accumulated sputum, grease spots will appear on the thin paper. As further proof the sputum is stained. The mineral oil droplets will take the characteristic stain with scarlet red, whereas the saponifiable fats and oils take the stain with osmic acid. The second confirmatory test is an aspiration biopsy of the affected portion of the lung which is then stained with scarlet red.

The treatment of mineral oil pneumonitis is started by advising the patient to discontinue taking mineral oil. The early changes may clear up spontaneously or may regress to a point where no further intervention is necessary. When superimposed infection or bronchiectasis complicates the picture lobectomy may be indicated.

All in all, it appears that by taking into consideration the above enumerated factors, a larger number of cases of mineral oil pneumonitis will be discovered during routine chest surveys. By properly differentiating this benign disease from primary carcinoma of the lung, some needless radical operations may be avoided. The recognition of the possible pulmonary hazard of mineral oil may also lead to prescribing of some other types of habitual laxatives for old people.

T. LEUCUTIA, M.D.



ANDERS PETER OVERGAARD

1879-1948

DR. ANDERS PETER OVERGAARD, Houston, Texas, radiologist, died on March 14, 1948. A native of Kennard, Nebraska, Dr. Overgaard was born March 4, 1879, the son of Anders C. and Dorthea Overgaard. He attended Kennard High School and the University of Nebraska College of Medicine, Omaha, from which

he was graduated in 1900. He served an internship at Paxton Douglas County Hospital, Omaha, and then practiced for fourteen years at Freemont and twenty-four years at Omaha before moving to Houston in 1940. He retired from active practice in 1947.

Since coming to Texas Dr. Overgaard

had been a member of the Harris County Medical Society, the State Medical Association, and the American Medical Association. He was a member of the South Texas District Medical Society and the Houston Academy of Medicine. He was an honorary member of the Harris County Medical Society and had been nominated for honorary membership in the State Medical Association at the time of his death. He was a diplomate of the American Board of Radiology, a charter member of the American College of Radiology, and a member of the American Roentgen Ray

Society and Radiological Society of North America. While in Nebraska, Dr. Overgaard had served as president of the Omaha Roentgen Society and Omaha-Douglas County Medical Society and as a councilor of the Nebraska State Medical Association. He was a member of the Episcopal Church, the Masonic Order, and the Shrine.

Dr. Overgaard is survived by his wife, the former Miss Gertrude Fleming of Fremont, Nebraska, whom he married in 1905.

C. P. HARRIS, M.D.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4-7, 1949.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1950, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill. Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. through April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg.,

Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. F. H. Ghiselin, 111 East 76th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Boyd Isenhardt, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. G. P. Keefer, 1930 Chestnut St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. K. C. Corley, 1835 Eye St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO**SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA**

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:

New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. I. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA**SOCIEDAD ARGENTINA DE RADIOLOGIA**

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGÍA, FILIAL DEL LITORAL

President, Dr. Francisco P. Cifarelli. Meets second

Wednesday each month, at 7:00 P.M., at 663 Italia St. in Rosario.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Andreilino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE**SOCIÉTÉ BELGE DE RADIOLOGIE**

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

DISTRIBUTION PROGRAM FOR CYCLOTRON-PRODUCED RADIOISOTOPES

Cyclotron-produced radioisotopes will be made available to research men in the United States under a program announced July 23, 1949, by the Atomic Energy Commission. With this additional supply of radioisotopes which are produced in the accelerator type of atom-smashing machines added to the varieties produced in the Oak Ridge reactor, researchers will have a new collection of tools for finding answers to problems in general science, medicine, industry, and agriculture.

The program will augment the present distribution of reactor-produced radioisotopes which has been in effect since August, 1946. Up to the present, 6,975 shipments of radioisotopes of nearly 60 elements representing nearly 100 isotopic species have been made for research purposes through the facilities of the Atomic Energy Commission.

Only those cyclotron-produced isotopes having half-lives of more than 30 days will be distributed initially. Included in these are 43-day beryllium 7, 3-year sodium 22, 44-day iron 59, 4-year iron 55, 250-day zinc 65, 90-day arsenic 63, and 56-day iodine 125. Other cyclotron-produced radioisotopes of significant value as tools of research may be added at a later date.

The new program was strongly recommended by the National Research Council, which stated that "there are significant numbers of radioisotopes which either cannot be produced by the uranium chain-reacting pile or cannot be so prepared as to meet certain requirements that are obligatory for many scientific applications." The National Research Council also pointed out that the great number of requests for cyclotron-produced isotopes make it impossible for any one cyclotron laboratory to satisfy the demand without seriously interfering with its research programs.

Processing of irradiated targets will be carried out by the Oak Ridge National Laboratory in facilities already provided

for handling reactor-produced isotopes. The Isotopes Division of the Commission will carry out the allocation function in the same manner as it now does with reactor-produced isotopes.

Cyclotron-produced radioisotopes, because of the method of their manufacture, are considerably more expensive than reactor-produced isotopes and in order to price them at a level which will make them available to most research institutions it will be necessary for the Commission to subsidize the program to a certain extent. In addition, these isotopes, like the reactor-produced radioisotopes now distributed by the Commission, also will be made available free of all production charges for cancer research.

Including distribution of cyclotron-produced isotopes in the present program for supplying reactor-produced radioactive isotopes will simplify maintenance of present policies on health safety requirements, disposal procedures, and criteria for use in human beings.

The distribution of materials produced under this program will be limited to institutions and organizations within the United States and its territories and possessions. Cyclotron-produced isotopes are more readily available abroad than reactor-produced isotopes because cyclotrons are in operation in many countries.

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

The United Nations Educational, Scientific and Cultural Organization (Unesco) proposes to publish later in the year a Manual on the International Exchange of Publications.

It is intended to publish as an annex to this Manual a classified list of institutions, including libraries, universities, scientific institutions, learned societies, etc. throughout the world, which are willing to exchange either their own publications or other publications which they have regularly at their disposal. In the course of its

activities Unesco has been able to obtain a considerable amount of information concerning the availability of exchange material, but the information at their disposal is still far from complete. All institutions which have so far not sent to Unesco details of their exchange material in one form or another are therefore urged immediately to communicate the following information to the Unesco Clearing House for Publications, 19 Avenue Kleber, Paris 16^e, France:

- (a) Name and full address of institution.
- (b) Exact titles of publications offered. (In the case of duplicates offered for exchange purposes actual lists of duplicates are not required, but only a statement that lists of duplicates are available. Institutions possessing a catalogue of their own publications available for exchange are asked only to send a copy of the catalogue or to give a full bibliographical description of the catalogue.)
- (c) Institutions which wish to exchange their publications only under certain conditions are asked to state what these conditions are.

Only information which reaches Unesco before October 1, 1949, can be used in the Manual and it is therefore in the interests of all institutions concerned to communicate immediately with the above address.

CONTINUATION COURSE IN PEDIATRIC ROENTGENOLOGY

The University of Minnesota announces a continuation course in Pediatric Roentgenology on October 31 through November 5, 1949. The course, which will be presented at the Center for Continuation Study, is intended for radiologists and pediatricians. The material to be presented will include the basic medical sciences, clinical medicine, and diagnostic roentgenology, as it pertains to general and special problems in the field of childhood diseases. Presentation will be by means of lectures, clinics, conferences, and round table discussions.

Distinguished visiting physicians who will participate as members of the faculty

for the course will include Dr. John Caffey, Babies Hospital, Columbia University Medical Center; Dr. Edward B. D. Neuhauser, Children's Hospital, Boston; Dr. Edith Potter, University of Chicago; and Dr. Frederic N. Silverman, Children's Hospital, Cincinnati. The remainder of the faculty for the course will be made up of clinical and full-time members of the staff of the University of Minnesota Medical School and the Mayo Foundation.

CORRECTION

A paper by Bernard Roswit and Gustave Kaplan entitled "The Role of Nitrogen Mustard (HN₂) as a Systemic Adjunct to the Radiation Therapy of Certain Malignant Diseases" appeared in this JOURNAL, May, 1949, Vol. 61, pp. 626-636. In the last paragraph on page 632 is this statement:

"Bronchogenic Carcinoma. In the Radiation Clinic more than 6,000 cases of inoperable bronchogenic carcinoma have received palliative deep roentgen therapy in the past fifteen years."

This contains an error as to the number of cases and it should read as follows:

"Bronchogenic Carcinoma. In the Radiation Clinic more than 600 cases of inoperable bronchogenic carcinoma have received palliative deep roentgen therapy in the past fifteen years."

CORRECTION

In my abstract of the article "Late Results of Radium Therapy for Carcinoma of the Uterine Cervix," *J.A.M.A.*, July 10, 1948, 137, 935-942, published in this JOURNAL in June, 1949, 61, p. 878, in next to the last paragraph on that page I have listed the percentage followed up as "(varying from 25 per cent to 43.6 per cent)." These figures actually represent variation in the percentage of five year survival of traced patients according to age group. The percentage of those traced out of the total number actually approximates 90 per cent.

WILLIAM E. HOWES, M.D.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Neck and Chest

- GREENFIELD, M. M.: Malignant plasmocytoma of the naso-pharynx..... 443
- BLACK, M.: Surgical aspects of hyperparathyroidism..... 443
- BREWER, L. A., III, JONES, W., and DOLLEY, F. S.: Non-malignant intrathoracic lesions simulating bronchogenic carcinoma..... 444
- GROW, J. B., BRADFORD, M. L., and MAHON, H. W.: Exploratory thoracotomy in the management of intrathoracic disease.... 444
- EVANS, B. H., and HAIGHT, C.: Surgical removal of unsuspected mediastinal lymphoblastomas..... 444
- WESTERMARK, N.: Importance of intralveolar pressure in the diagnosis of pulmonary disease..... 445
- PERRY, S. P., and SHAPIRO, R.: Suppurative bronchopneumonia with cavitation..... 445
- KERSHNER, R. D., and ADAMS, W. E.: Chronic nonspecific suppurative pneumonitis..... 445
- MACHLE, W., and GREGORIUS, F.: Cancer of respiratory system in the United States chromate-producing industry..... 446
- FARBER, S. M., BENIOFF, M. A., and TOBIAS, G.: Primary carcinoma of the lung..... 446
- MOYSÉS, J.: Pulmonary blastomycosis..... 446
- PENDERGRASS, E. P., and ROBERT, A. G.: Roentgen diagnosis of silicosis and conditions that may simulate it..... 447
- HATCH, T. F.: Significance of occupational history in diagnosis of silicosis..... 447
- CORCORAN, W. J.: Anthraco-silicosis..... 447
- PRINZEMETAL, M., *et al.*: Radiocardiography..... 448

Abdomen

- EVANS, W. A.: Obstructions of the alimentary tract in infancy..... 448
- SWENSON, P. C., and MANGES, W. F.: Roentgen findings in functional disturbances of the gastro-intestinal tract..... 448
- RAVITCH, M. M.: Polypoid adenomatosis of entire gastro-intestinal tract..... 449
- RIGLER, L. G.: Roentgen examination of stomach in symptomless persons..... 449
- WARREN, R., and LANMAN, T. H.: Surgery in bleeding peptic ulcer..... 450

- PARTINGTON, P. F., and SACHS, M. D.: Routine use of operative cholangiography..... 451
- BULLOCK, W. K., and EDMONDSON, H. A.: Pancreatic lithiasis and calcification..... 451
- HIATT, R. B., and WILSON, P. E.: Celiac syndrome. VII..... 451

Genitourinary System

- ZATZKIN, H. R.: Effective compression in excretory pyelography..... 452
- BRODNY, M. L., and ROBINS, S. A.: Urethro-cystography in male child..... 452
- FISHER, R. S., and HOWARD, H. H.: Unusual ureterograms in case of periarteritis nodosa..... 453
- COTTLER, Z. R.: Nonhormonal adrenal cortical carcinoma..... 453
- KRETSCHMER, H. L., and McDONALD, J. K.: Carcinoma of the bladder with bone metastases..... 454
- ROBINS, S. A., and FISCHMANN, J.: Hydro-nephrosis..... 454

Skeletal System

- PONSETI, I.: Evolution and treatment of tuberculosis of the hip..... 454
- ESGUERRA-GOMEZ, G., and ACOSTA, E.: Bone and joint lesions in leprosy..... 455
- BROMER, R. S., and HARVEY, R. M.: Roentgen diagnosis of rickets associated with other skeletal diseases of infants and children..... 455
- NEUHAUSER, E. B. D., *et al.*: Progressive diaphyseal dysplasia..... 455
- COLEY, B. L., HIGINBOTHAM, N. L., and BOWDEN, L.: Endothelioma of bone..... 455
- SHERMAN, R. S., and STERNBERGH, W. C. A.: Roentgen appearance of ossifying fibroma of bone..... 456
- CAMP, J. D., and SCANLON, R. L.: Chronic idiopathic hypertrophic osteo-arthritis..... 456
- FAIRBANK, H. A. T.: Melorheostosis..... 457
- FAIRBANK, H. A. T.: Osteopoikilosis..... 457

Blood and Lymph System

- BLEICH, A. R., and KIPEN, C. S.: Venous calcification in Banti's syndrome..... 458
- WESTERMARK, N.: Studies of the circulation by roentgencinematography..... 458

ROENTGEN AND RADIUM THERAPY

- PENDERGRASS, E. P., and MAHONEY, J. F.: Consideration of roentgen therapy in producing temporary depilation for tinea capitis..... 458
- DONLAN, C. P.: Tumor dose in cancer of larynx..... 459
- NOHRMAN, B. A.: Experiences drawn from treatment of cancer of breast by roentgen irradiation combined with Halsted operation..... 459
- MAISIN, J.: Role of irradiation in treatment of cancer of breast..... 459
- THAYSSSEN, V. E.: Influence of castration by roentgen on carcinoma of the breast.... 460
- LEWIS, L. G.: Radical orchiectomy for tumors of the testis..... 460
- MUSGROVE, J. E., and McDONALD, J. R.: Extra-abdominal desmoid tumors..... 460
- SCHMITZ, H. E., and TOWNE, J. E.: Treatment of pelvic endometriosis..... 461
- BRUNSCHWIG, A.: Complete excision of pelvis viscera for advanced carcinoma..... 461
- MILLER, N. S.: Carcinoma of the uterus, ovary and tube..... 461
- DIDDLE, A. W., and BENNETT, T. R.: Carcinoma of cervix in an urban population.. 462
- MARKS, J. H., and WITTENBERG, M. H.: Results of treatment of carcinoma of ovary with data on age incidence of this disease. 463

- CAHAN, W. C., *et al.*: Sarcoma arising in irradiated bone..... 464
- CRAVER, L. F.: Nitrogen mustards..... 464
- BURCHENAL, J. H.: Newer nitrogen mustards in treatment of leukemia..... 464

RADIOISOTOPES

- WRIGHT, H. P., OSBORN, S. B., and EDMONDS, D. G.: Rate of flow of venous blood in the legs measured with radioactive sodium.. 465
- ROWLANDS, S., ROWLEY, D., and STEWART, H. D.: Absorption and excretion studies with radioactive penicillin..... 465
- SMITH, R. E., and BRONSON, J. F.: Improved radioactivity measuring cup..... 465

MISCELLANEOUS

- EPSTEIN, B. S.: Laminagraphy through plaster casts in postreduction roentgenography of congenitally dislocated hips..... 465
- JACOBSON, L. O., *et al.*: Studies on radiosensitivity of cells..... 465
- MURPHY, J. B., and STURM, E.: Effect of growth or retrogression of a transplantable lymphosarcoma of the rat on the lymphoid organs and adrenals of the hosts. 466
- SKAGGS, L. S., *et al.*: Development of betatron for electron therapy..... 466
- SHULL, C. G., and WOLLAN, E. O.: X-ray, electron, and neutron diffraction..... 466

ROENTGEN DIAGNOSIS

NECK AND CHEST

GREENFIELD, MAURICE M. Malignant plasmocytoma of the naso-pharynx: *Radiology*, May, 1948, 50, 661-665.

A case history is presented of a twenty year old male with a right cervical adenopathy and small areas of destruction of the sixth rib on both sides. Biopsy revealed plasmocytoma for which he received intensive irradiation. One and one-half years later, he complained of nasal obstruction and right orbital headaches. Polypoid growths were removed from the nose in 1943 and had now recurred. Biopsy revealed plasmocytoma and roentgenograms showed bone destruction in the region of the right orbit. The case is presented to show the malignant character of plasmocytoma and its semiresistance to irradiation.—C. H. Warfield, M.D.

BLACK, MARDEN. Surgical aspects of hyperparathyroidism; review of sixty-three cases. *Surg., Gynec. & Obst.*, Aug., 1948, 87, 172-182.

Sixty-three patients with proved hyperparathyroidism were observed at the Mayo Clinic through 1946. The disease was due to a single adenoma in 56 cases, to multiple adenomas in 3 cases and to diffuse primary hyperplasia in 4 cases. The ages of the patients ranged from the second to the seventh decade. Complications of the urinary tract were more common and more important than osseous complications.

About 20 per cent of the patients had generalized osteitis fibrosa cystica without renal complications. Somewhat less than 20 per cent had both renal complications and osteitis fibrosa cystica. Slightly more than 20 per cent had renal complications and some osteoporosis but not osteitis fibrosa cystica. Approximately 35

per cent had complications of the urinary tract and no evidence of osseous disease. Generalized osteitis fibrosa cystica was present in less than 40 per cent of cases while nephrocalcinosis or urinary lithiasis was found in more than 70 per cent.

The diagnosis was established with certainty in 3 cases in the absence of any complications on the basis of the characteristic changes in the content of calcium and phosphorus in the blood and urine. Since the diagnosis can be made with complete certainty, exploration of the parathyroid glands is never indicated to establish the diagnosis and the surgeon must accept the fact that in every case of hyperparathyroidism one adenoma or more or primary hyperplasia is present.

The treatment of hyperparathyroidism is surgical. Adenomas should be removed completely and in cases of diffuse primary hyperplasia, the hyperplastic tissue should be excised subtotally with the preservation of between 30 and 200 milligrams of hyperplastic tissue.—*Mary Frances Vastine, M.D.*

BREWER, LYMAN A., III, JONES, WILFRED, and DOLLEY, FRANK S. Non-malignant intrathoracic lesions simulating bronchogenic carcinoma. *J. Thoracic Surg.*, Aug., 1948, 17, 439-463.

Thirty operated cases are presented in which although peripheral carcinoma of the lung was suspected, various benign lesions were found. This group consisted of 20 inflammatory conditions, 6 benign tumors, and 4 developmental abnormalities.

The diagnosis and differential diagnosis are discussed and diagrammatic representations of the roentgenograms are presented.

The difficulty of the clinical problem in the early diagnosis of bronchogenic carcinoma is emphasized by the fact that in only one-half of the cases treated by the authors could the carcinoma be diagnosed by bronchoscopy. Most often the differentiation between peripheral malignancies and non-malignant conditions cannot be made without exploratory thoracotomy. The authors believe that the management of a suspected case of peripheral bronchogenic carcinoma has reached a status similar to that of suspected carcinoma of the breast with exploration, biopsy, and radical excision, if cancer is proved.—*Frederick Reis, M. D.*

GROW, JOHN B., BRADFORD, MARTIN L., and MAHON, HUGH W. Exploratory thoracotomy in the management of intrathoracic disease. *J. Thoracic Surg.* Aug., 1948, 17, 480-493.

Two hundred cases in which exploratory thoracotomy was performed for the diagnosis and treatment of obscure intrathoracic disease are presented. Malignant tumors occurred in 21.5 per cent of the cases. The accepted methods of differential diagnosis are discussed and their limitations indicated. The pathologic diagnosis of these cases and the roentgen appearance are shown in tables and several cases are illustrated by reproductions of roentgenograms.

A negative bronchoscopy is of no value in excluding intrathoracic neoplasm.

The accepted practice of using roentgen therapy as an adjunct in the diagnosis of malignant lymphomas is condemned because:

1. Not all malignant lymphomas respond to the roentgen therapy.
2. Many benign lymphadenopathies and resectable malignant lesions of the thymus do respond to irradiation and would lead to an erroneous diagnosis.
3. There are indications that the prognosis of localized mediastinal lymphoma is improved by combined resection and radiation therapy.
4. The prompt establishment of a histopathologic diagnosis expedites initiation of treatment.

About 25 per cent of circumscribed parenchymal lesions were found to be malignant. This emphasized the necessity of early exploration in undiagnosed lesions of this type.—*Frederick Reis, M.D.*

EVANS, BYRON H., and HAIGHT, CAMERON. Surgical removal of unsuspected mediastinal lymphoblastomas. *Arch. Surg.*, Sept., 1948, 57, 307-324.

Four cases of mediastinal lymphoblastomas which simulated benign lesions are discussed. Two were Hodgkin's disease and 2 lymphosarcoma.

Single unilateral circumscribed mediastinal lymphoblastic tumors are uncommon. The roentgenologic picture closely simulates dermoid or teratomatous tumors. Even if suspected, their response to test doses of irradiation is so limited this method of differential diagnosis may be fallacious.

In 3 cases the correct diagnosis was not suspected. The fourth was not given a test dose of irradiation. Six previous cases removed surgically are discussed. One case of Hodgkin's disease in this series of 4 was given 400 r, in air, anteriorly and posteriorly one month after operation. The patient lived seven and one-half years. A case of lymphosarcoma was given 1,200 r, in air, anteriorly and posteriorly postoperatively and was well five years later. Two other cases, one of Hodgkin's disease and one of lymphosarcoma were well five years later, having no irradiation. A long survival without symptoms is not considered a cure because of possibility of late recurrences. It is not the authors' intention to remove isolated lymphoblastoma. It can be said that their patients were improved rather than harmed by operation.—*Thomas L. Martin, M.D.*

WESTERMARK, NILS. Importance of intra-alveolar pressure in the diagnosis of pulmonary disease. *Radiology*, May, 1948, 50, 610-618.

The degree of filling of the pulmonary vessels, of the capillaries and of the chambers of the heart is profoundly affected by the intra-alveolar pressure. Westermarck demonstrates this by having the patient hold a tube from a water manometer in his mouth and varying the pressure from minus 15 cm. of water up to plus 80 cm. of water. Roentgenograms are taken at the proper pressures.

This method is of value in obtaining roentgenograms at various intervals in which the vascular structures remain at the same size, since standard conditions of intra-alveolar pressure can be maintained. He has also been able to demonstrate that the volume of the heart can increase by up to one-third when the pressure is low and decrease by one-third when a high pressure exists.

Roentgenograms made at normal levels and at high pressures will give a rough estimate of the pressure in the pulmonary arteries since the point at which the arteries in the hilum decrease in size can be determined.

Roentgenograms made during positive intra-alveolar pressure may reveal lymph nodes in the hilum not otherwise demonstrable, the diminished size of the vessels making the nodes more easily visible.

In moderate degrees of congestion, in pulmonary edema and in acute bronchopneumonia of

an early stage, definite diminution or disappearance of some of the shadows can be demonstrated under high pressure conditions.

In acute lobar pneumonia, in atelectasis, in chronic pneumonia and in most cases of tuberculosis changes are minor or absent.

This is an interesting article and well worth reading in the original.—*Frank J. Riggs, M.D.*

PERRY, S. PAUL, and SHAPIRO, ROBERT. Suppurative bronchopneumonia with cavitation. *Radiology*, March, 1948, 50, 351-364.

Seven cases of a rather bizarre type of bronchopneumonia characterized by parenchymal suppuration and necrosis with cavity formation have been added to the sparse radiologic literature pertaining to this entity. The patients were young adults and the incidence of this condition was 0.2 per cent of all cases of pneumonia observed at a naval hospital during a period of several months. All the reported cases recovered without complications under sulfonamide and penicillin therapy; hence, material for pathological study was not available. Cultures of sputum tended to implicate the B-hemolytic streptococcus as the etiological agent in 4 cases. Some of the cases followed in the wake of an epidemic of scarlet fever, and frequently there was a history of antecedent upper respiratory tract infection. The chief symptoms were fever, cough and the expectoration of purulent sputum; pleuritic pain was common. Physical and laboratory findings were not characteristic and the diagnosis depended primarily upon the roentgen demonstration of cavitation within an area of consolidation. Serial films combined with appropriate clinical and laboratory examinations were of particular value in differentiating the more severe forms from other diseases, such as tuberculosis.—*William N. Thomas, M.D.*

KERSHNER, RICHARD D., and ADAMS, W. E. Chronic nonspecific suppurative pneumonitis. *J. Thoracic Surg.*, Aug., 1948, 17, 495-513.

Ten cases of chronic nontuberculous inflammation of the lungs are reported which present a clinical entity unlike that of lung abscess and bronchiectasis. It must be differentiated from bronchogenic carcinoma, chronic lung abscess, tuberculosis and bronchiectasis. The principal features of differential diagnosis are a gradual onset of symptoms without obvious cause, and

diffuse infiltration of the lungs without bronchial dilatation or cavity formation on roentgen examination.—*Frederick Reis, M.D.*

MACHLE, WILLARD, and GREGORIUS, FREDERICK. Cancer of the respiratory system in the United States chromate-producing industry. *Pub. Health Rep.*, Aug. 27, 1948, 63, 1114-1127.

A high incidence of cancer of the lung had been noted by the management of a plant producing chromates. This stimulated a further study by the health committee of the chromate industry. Six plants were selected concerned with the extraction of chromate from ore.

The study was made by a statistical compilation obtained from mortality data of these plants and comparing them to other industrial plants for the control group.

The findings were a consistent high rate of deaths from cancer of the lung in the plants concerned. The individual ratios varied from 13 to 31 times the normal. The overall ratio was 16 times the expected ratio of 1.3 per cent. The increase was in both the groups of below the age of fifty years and the group above.

The deaths from cancer elsewhere were the same as in the control group. The ratio for pneumonia was also higher in this group than in the control.

Evidence suggests that the carcinogenic compounds of chromium are the monochromates as this high rate of carcinoma of the lung was not found in the groups not exposed to this compound.

Roentgenograms of chests were not taken.—*Joseph Levitin, M.D.*

FARBER, S. M., BENIOFF, M. A., and TOBIAS, G. Primary carcinoma of the lung; diagnosis by cytological studies of sputum and bronchial secretions. *California Med.*, Aug., 1948, 69, 95-99.

In bronchogenic carcinoma, tumor cells often exfoliate into the adjacent bronchial lumen. Demonstration of neoplastic cells in the sputum is a valuable early method of suggesting or establishing the presence of malignancy.

With careful collection, selection, preservation, and staining of sputum or bronchoscopic aspiration samples, using a technique similar to the Papanicolaou method of vaginal smear examination, a high diagnostic accuracy may be

attained. Previous observers have demonstrated tumor cells in 84 to 89 per cent of patients with proved bronchogenic carcinoma. In the present authors' series of 52 patients with proved malignancy, 43, or 82 per cent, had positive or suspicious smears. In a series of 1,512 specimens from 414 patients suspected of having bronchogenic carcinoma, positive or suspicious cells were found in 69 patients, 56 of whom were subsequently shown to have bronchogenic carcinoma.

This technique is useful in the study of peripheral lesions not accessible to bronchoscopic biopsy, and in demonstrating malignancy in patients with pre-existing pulmonary tuberculosis. Failure to find tumor cells on a single specimen does not rule out the possibility of malignancy. In many of the author's patients, five or more specimens were examined before tumor cells were seen.—*Henry P. Brean, M.D.*

MOYSÉS, JOSÉ. Blastomicose pulmonar. (Pulmonary blastomycosis.) *Brasil méd. cir.*, Sept., 1948, 10, 497-500.

Blastomycosis has been described in the medical literature under different synonyms of which "Brazilian paracoccidiosis," "blastomycoid granuloma," "parablastomycosis," "Lutz' mycosis" or "Brazilian blastomycosis" are most frequently encountered in Brazil.

In autopsy studies pulmonary localization of the disease was observed in 84 per cent of the cases. According to Amadeu Filho the pulmonary manifestations of blastomycosis may be classified as (1) small lesions of granular type; (2) nodular well circumscribed acinous or acinodular lesions of predominantly granulomatous type; (3) extensive infiltrative lesions of predominantly granulomatous or exudative type; (4) abscesses; (5) ulcerative, more or less acute lesions, without evidence of encapsulation; (6) ulcerative, more chronic lesion, with evidence of encapsulation, and (7) nodular lesions with spontaneous regression.

The difficulty of the differential diagnosis from pulmonary tuberculosis is evident; in about 15 per cent of the cases, blastomycosis is associated with tuberculosis.

The clinical history (with roentgenograms) of a sixty year male patient, suffering from extensive bilateral exudative blastomycosis of the lungs and apparently completely cured by means of sulfadiazol, is presented in detail.—*Ernst Schmidt, M.D.*

PENDERGRASS, EUGENE P., and ROBERT, AGRIPPA G. Some considerations of the roentgen diagnosis of silicosis and conditions that may simulate it. *Radiology*, June, 1948, 50, 725-745.

Pneumoconiosis is a broad generic term used to describe all forms of pulmonary reaction to dust lodging within the lungs, with no implication as to character, severity, or effect on function. Certain of these reactions may be demonstrated by roentgen examinations of the chest, but in most instances they are entirely non-specific, are unaccompanied by formation of progressive fibrosis, and are of no clinical significance. The authors recognize two clinically important specific pneumoconioses, namely silicosis and asbestosis, as well as a number of benign pneumoconioses resulting from the inhalation of a variety of inert but radiopaque dusts. The former may be productive of disability, whereas the latter are of clinical significance only because they may lead to errors in diagnosis through their ability to produce upon the roentgenogram a nodular pattern, at times indistinguishable from that occurring in silicosis.

For accurate diagnosis of silicosis there is necessary a positive history of sufficient exposure to free silica dust plus the roentgenologic demonstration of characteristic deviations from the normal within the lungs. Physical and laboratory examinations are then required to exclude other conditions producing similar roentgenographic changes.

Reproductions of roentgenograms are shown, again reiterating the various stages of the disease and also the importance of associated infections, both nonspecific and tuberculous. The histopathology of silicosis is reviewed in detail. Criteria of asbestosis diagnosis is not reviewed.

A considerable part of the treatise is concerned with the differential diagnosis of other inhaled dusts as well as other pulmonary manifestations of disease not produced by dust inhalations.—E. A. Addington, M.D.

HATCH, THEODORE F. Significance of occupational history in diagnosis of silicosis. *Radiology*, June, 1948, 50, 746-750.

Since the pulmonary changes of silicosis as revealed by the roentgenogram are not characteristic of that disease alone, an occupational history is an essential aid in accurate interpretation of the roentgenogram of the chest. There

must be confirming evidence of sufficient exposure to silicosis producing dust before a diagnosis of silicosis can be made on the roentgenograms.

The thesis of this paper is a plea for more detailed study of particle size, composition in relation to particle size, and dust concentration in intermediate industries and occupations in which silicosis occurs sporadically. There is a definite danger in shortcut methods of assessing dust hazards, and the author points out why the usual methods are not accurate in these types of industries and occupations.—E. A. Addington, M.D.

CORCORAN, WILLIAM J. Anthraco-silicosis. *Radiology*, June, 1948, 50, 751-754.

This is a review of observations made in coal miners with anthracosilicosis in the anthracite coal fields over a period of twenty-seven years.

It is the opinion of the author that when a man is exposed to a silica hazard, it takes from five to seven years before there were any distinctive changes in the lungs that can be noted on the roentgenogram. The diagnosis of anthracosilicosis cannot be made with any degree of assurance on the roentgenogram alone in the first stage. The history must be obtained. This is not true concerning the second and third stages of the disease. Their roentgenographic appearances are characteristic and the diagnosis can be made with less consideration of the history.

Fluoroscopy is a most valuable aid and has been much neglected in the evaluation of silicosis of the lungs. Also of value is the taking of films in inspiration and expiration.

Infection is not often encountered in either lung in the first two stages of the disease. It is in the third stage that infection occurs most frequently. After the age of fifty, and usually in the third stage, tuberculosis is more common in silicotic individuals than in those not so affected.

The author states that anthracosilicosis is a progressive incurable disease and then states he has never known of a case in which a first stage silicotic, after having been removed from the dust hazard, went on into a third stage silicotic. Those in the late second stage will go on into the third stage but will progress more slowly if they are removed from the hazard. The author has never seen an instance of total and permanent disability from anthracosilicosis

alone unless the disease had advanced well into the third stage.

A short discussion of protection methods is included. Investigation of the use of aluminum in counteracting the deleterious effects of silica is mentioned.—*E. A. Addington, M.D.*

PRINZEMETAL, MYRON; CORDAY, ELIOT; BERGMAN, H. C.; SCHWARTZ, LOIS, and SPRITZLER, R. J. Radiocardiography: a new method for studying the blood flow through the chambers of the heart in human beings. *Science*, Sept. 24, 1948, 108, 340-341.

Passage of radioactive substances through the cardiac chambers can now be graphically recorded with a specially constructed, ink writing Geiger-Müller counter.

Technique is described, charts are included in the article and curves explained.

Two hundred and fifty subjects were given injections for study with no untoward effects. The amount of radiation is much less than the amount patient receives during various diagnostic roentgen examinations.

Studies on hemorrhagic shock, tetralogy of Fallot and determination of circulation time are mentioned.—*Anthony F. Rossitto, M.D.*

ABDOMEN

EVANS, WILLIAM A. Obstructions of the alimentary tract in infancy. *Radiology*, July, 1948, 51, 23-35.

This paper reviews the alimentary obstructions which occur in infancy and emphasizes their roentgen diagnosis. The basis of the paper is 400 cases of obstructing or potentially obstructing lesions.

Infantile hypertrophic pyloric stenosis reveals a persistently long narrow pyloric canal which can be seen fluoroscopically and spot filmed. It may be necessary to aspirate and lavage the stomach before giving the small (5-10 cc.) barium meal. Barium enema indicates the extension of intussusception into the colon and the degree of gaseous distention of the small bowel. Intussusception may be partially or totally reduced by the procedure. Esophageal atresia should be suspected in the newborn from the appearance of abundant frothy sputum in the mouth. Food and barium should be withheld. An opaque catheter passed into the esophagus will indicate obstruction. In atresia of the duodenum the stomach and

duodenum proximal to the atresia are outlined by gas. Absence of gas in the lower small bowel and colon indicates complete obstruction. Roentgenologically, meconium ileus, volvulus and atresia of the ileum may be indistinguishable. A barium enema determines whether the gaseous distention is confined to the small bowel and also locates the cecum for evidence of a malrotation pointing to a volvulus. With imperforate anus the extent to which the bowel is patent can usually be determined in the inverted vertical position. Neither this method nor the lateral projection with the knees tightly flexed on the abdomen is without error.

Gas may not displace impacted meconium in the rectum. Meconium ileus can be recognized if there is no abrupt termination of the gas distended bowel and if there is emulsified gas and meconium. A barium enema examination will show a small lumen of the large bowel and an obstruction to the barium flow possibly in the region of the splenic flexure. The author states malrotation of the colon is the basis of volvulus of the mid-gut. Early in this condition there is evidence of obstruction of the duodenum; later, the jejunum and ileum become distended. Two cases are shown which gave clinical and roentgenographic evidence of obstruction where no anatomical obstruction existed.—*Oliver P. Winslow, Jr., M.D.*

SWENSON, PAUL C., and MANGES, WILLIS F. Roentgen findings in functional disturbances of the gastro-intestinal tract. *Radiology*, March, 1948, 50, 365-377.

The normal and pathological physiology of the alimentary canal is discussed.

The esophagus exhibits three forms of muscular activity:

1. Primary pharyngeal contraction waves.
2. Secondary waves attributed to local mechanical stimulation. These act as true peristaltic waves and travel in both directions.
3. Tertiary contractions which give the esophagus a serrated appearance sometimes called "curling." These are increased in esophagitis and rarely marked in the normal organ.

If inflammation, neoplasm and obstruction can be ruled out the radiologist can conclude that dysphagia has its origin in the central nervous system or in some primary myopathy. Antral spasm and pylorospasm should be considered as due to local disease only when a

definite organic lesion can be shown. Ulcers should not be diagnosed on functional irregularities alone. Apparent pylorospasm will frequently disappear when food is mentioned to the patient.

Occasionally true antiperistalsis is seen in the duodenum. A partial regurgitation, not due to antiperistalsis, is frequently seen in the region of the superior mesenteric artery. This is considered a relatively normal physiologic obstruction. An organic obstruction may occur in anorexia nervosa due to weight loss and consequent dragging of the mesenteric root and its vessels over the distal portion of the duodenum.

Reflex motor disturbances from the stomach, diseases of the mesentery and retroperitoneal lesions, emotional states, allergic conditions and deficient nutrition can cause function disturbances of the small intestine.

Voluntary change of bowel habits, congenital anomalies and the use of cathartics can upset the functioning of the large bowel. Scybala in the rectum indicate disturbed motility. The rectum should be empty except during defecation.

The alimentary canal has its own inherent mechanism which can be modified and controlled by the autonomic nervous system. This secondary control may take a prominent part in the regulation of the entire tract or any portion thereof in functional diseases.—*Oliver P. Winslow, Jr., M.D.*

RAVITCH, MARK M. Polypoid adenomatosis of the entire gastro-intestinal tract. *Ann. Surg.*, Aug., 1948, 128, 283-298.

The author reports 2 interesting and unusual cases in which all segments of the gastrointestinal tract were involved in polypoid adenomatosis. At the autopsy of the first case, an eighteen month old white male, the mucosa from the cardia of the stomach to the anus was covered with innumerable polyps without "skip areas." A barium enema revealed the multiple polyps in the colon, but a small bowel study with the introduction of barium through a Miller-Abbott tube did not demonstrate polyps. The child died after operation for intussusception in the ileum.

In the second case, a sixteen year old white girl, an emergency exploratory operation revealed polyps of the stomach and several segments of the small bowel. Strangely enough

these could not be demonstrated with repeated roentgenographic studies. She had peculiar brown pigment in irregular flecks on the lips and oral mucosa which was first described by Hutchinson in association with intestinal polyps.

Polypoid adenomatosis of the colon is a definite clinical entity with a familial incidence. In the review of the literature the author quotes the high incidence of malignant change in these cases and stresses the importance of complete colectomy. Adenomatosis of the small intestine often first manifests itself by intussusception. In the author's experience, polyps of the small intestine are difficult to demonstrate roentgenographically. All polyps of the stomach should be considered potentially malignant and subtotal gastric resection is advised as the treatment of choice.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

RIGLER, LEO G. Roentgen examination of the stomach in symptomless persons. *J.A.M.A.*, Aug. 21, 1948, 137, 1501-1507.

The vast majority of persons coming to surgical treatment for carcinoma of the stomach are in the advanced stage of the disease and results are still exceedingly poor. Some means must be devised to discover carcinoma of the stomach when the lesion is small and in an early stage of development. Because of the insidious onset, diagnosis must be made before the development of any appreciable symptoms or physical signs. The only method which appears to be universally applicable and reasonably accurate is routine roentgen examination of the stomach. However, because the incidence of carcinoma of the stomach is relatively low, probably not more than three per thousand of the living population over the age of forty-five, the productivity of routine roentgen examination is of such an order as to discourage efforts to undertake it.

The first question which must be answered is whether or not the roentgen method is actually an accurate procedure for the diagnosis of early carcinoma of the stomach. The author has already had some experience in this field in previous studies on routine roentgen examination of the stomach in patients with pernicious anemia and achlorhydria. He has demonstrated that it is possible to diagnose extremely small polypi and also small carcinomas. Nevertheless, it must be admitted that when small lesions are being searched for the percentage of error

will rise appreciably and positive errors will likewise be increased in their frequency.

In the practical consideration of the feasibility of extensive routine examinations of symptomless persons certain short cuts should be considered. One of these is the selection of groups of persons in whom the incidence of carcinoma would be greater than in the general population. Certain factors which seem to be associated with or to precede carcinoma of the stomach (age; family history of carcinoma of the stomach, pernicious anemia or achlorhydria; atrophic gastric mucosa; gastric ulcer; occult blood in the stool) are not sufficiently definitive to be of practical use in selection of cases. Achlorhydria and hypochlorhydria are common accompaniments of gastric cancer. By gastric analysis of all persons past the age of fifty, followed by roentgen examination for all those who show achlorhydria or hypochlorhydria, the vast majority of carcinomas should be discovered. Pernicious anemia is another condition closely associated with carcinoma of the stomach as established by previous studies. Repeated examination at semiannual intervals of patients with pernicious anemia results in the detection of a considerable number of early cancers of the stomach; however, only 5 per cent of persons with carcinoma of the stomach have pernicious anemia.

Another short-cut would be the development of means by which the roentgen examination might be rendered less arduous, time consuming and expensive. Use of fluoroscopy alone would eliminate the expense of the film examination, but would not eliminate the time required of the radiologist. It is generally conceded that small lesions may be overlooked even by experienced fluoroscopists. Examination by films alone eliminates the expense of the time spent by the radiologist in fluoroscopy, but if the examination is to be accurate, the large number of films involved and the elaborate technique necessary to make an adequate examination would result in considerable expense. The conventional method of a combination of fluoroscopy, spot-filming, and roentgenographic examination is undoubtedly the most accurate but is expensive and time consuming. Photo-fluorography materially reduces the expense of the examination and the time consumed by the radiologist. None of these short-cuts is entirely satisfactory and the comparative accuracy of the various methods in diagnosing small lesions

needs to be evaluated. It seems reasonable to propose that a number of studies be undertaken on a small scale by these various methods in order to ascertain how accurate each is and how rapidly and inexpensively they could be achieved.

The author reports his results in a study of a series of patients selected with three criteria in mind. All patients were over the age of fifty, had no particular gastric symptoms and showed either achlorhydria or free hydrochloric acid of less than 30 units. Roentgen examination of the stomach was done at semiannual intervals. Five hundred forty-four such persons were examined. Fourteen cases of gastric carcinoma were discovered and one additional should have been found, but was missed as a result of error in interpretation. Eleven of the cases did have remote or minor symptoms and therefore did not fall into the category of truly symptomless persons. In addition, there were 9 patients with gastric polypi and numerous other abnormalities such as hiatus hernia, duodenal deformity and enlarged gastric rugae. The author concludes that the studies indicate the feasibility and value of routine roentgen examination of symptomless persons in selected groups for the discovery of gastric tumors.—*Leslie K. Sycamore, M.D.*

WARREN, RICHARD, and LANMAN, THOMAS H.
Surgery in bleeding peptic ulcer. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 291-298.

Summary and Conclusions

1. The use of methods of nonsurgical treatment of massive bleeding from peptic ulcer has always resulted in a small percentage of cases which come to the surgeon because medical measures have failed. In these cases, especially if there has been a prolonged trial of such a medical regimen, the postoperative mortality is high.

2. Early "urgent" operation is, therefore, advocated on all patients with massive hemorrhage from peptic ulcer who are over 45 years of age and in whom the hemorrhage persists after 48 hours following admission to the hospital (or having stopped, recommences).

3. Subtotal gastrectomy with removal of the lower two-thirds of the stomach, including the pylorus, should be the surgical plan for these patients.

4. In those patients in whom the ulcer is

technically difficult to remove, a subtotal gastrectomy with exclusion, but not removal, of the ulcer is advocated. In patients with a large inflammatory mass involving the pylorus and duodenum, a two stage subtotal gastrectomy as described by McKittrick should be done.—*Mary Frances Vastine, M.D.*

PARTINGTON, PHILIP F., and SACHS, MAURICE D. Routine use of operative cholangiography. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 299-307.

The need for additional diagnostic methods to improve the results in gallbladder surgery has long been acknowledged. The possibility that careful study of diagnostic methods other than operative ones might improve results led Mirizzi, Best, Hicken and others to the use of immediate or operative cholangiography.

The purpose of this paper is to report the authors' results with the routine use of operative cholangiography on all patients requiring gallbladder or common duct surgery during the year 1946-1947.

Technique. The only special equipment necessary is a plywood tunnel which is placed beneath the patient's lower thorax and abdomen without an intervening mattress. This tunnel is large enough to hold a 14 by 17 inch cassette and a grid. The surgeon places a tie on the cystic duct close to the gallbladder to prevent injection of radiopaque material into the gallbladder. The authors use 70 per cent diodrast as the contrast medium. It is injected through a small needle after being warmed to body temperature. The needle is inserted into the common duct and 20 cc. of the material is injected slowly. The exposure is made during a period of respiratory arrest induced by carbon dioxide. Intratracheal nitrous oxide, oxygen and ether constitute the anesthetics used.—*Mary Frances Vastine, M.D.*

BULLOCK, W. K., and EDMONDSON, H. A. Pancreatic lithiasis and calcification. *California Med.*, Aug., 1948, 69, 104-108.

Pancreatic lithiasis may be asymptomatic, or associated with intermittent upper abdominal pain, elevated serum lipase and amylase levels, and hyperglycemia. Later, diabetes mellitus and steatorrhea may appear. The appearance of calculi following one to fourteen years of chronic pancreatitis has been described. Many but not all patients are alcoholics.

Pancreatic calcification may be demonstrated on plain films of the abdomen. In the lateral view, calculi in the head and body of the pancreas lie just anterior to the lumbar spine; calculi in the tail lie more posteriorly, in the plane of the lumbar vertebral bodies. Calcification may be in the form of separate intraductal stones, or in a very fine stippled calcification usually involving all or most of the gland. Duodenal aspiration after intravenous injection of secretin may show lack of the normal increase in bicarbonate and pancreatic enzymes. The stools may show undigested fat, and the glucose tolerance test may reflect damage to the islets of Langerhans.

Twenty-two cases of pancreatic calculi and calcification were found by the authors in a series of 35,000 necropsies, an incidence of 0.062 per cent, comparable to the incidence of 0.044 per cent previously reported in another large postmortem series. However, careful dissection of a series of postmortem pancreases after postmortem roentgenography by Lüdin uncovered 28 cases in 542 pancreases, an incidence of 5.1 per cent.

Clinical features in the authors' 22 cases, in order of frequency, were weight loss, jaundice, enlarged liver, upper abdominal pain, weakness, nausea, vomiting, constipation, edema, ascites and steatorrhea. Seven patients had diabetes mellitus, and 10 were alcoholics. Eleven had cirrhosis of the liver at autopsy.—*Henry P. Brean, M.D.*

HIATT, ROBERT B., and WILSON, PAUL E. Celiac syndrome. VII. Therapy of meconium ileus; report of eight cases with a review of the literature. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 317-327.

The association of meconium ileus with pancreatic cystic fibrosis was first described by Landsteiner in 1905. Since then there have been 11 other cases reported in each of which meconium ileus has been noted at operation and fibrocystic disease of the pancreas described following autopsy. Thus the coexistence of these two conditions has been well established. Seven additional cases have been found in the pathological records of the Babies Hospital.

Two hypotheses have been suggested to explain the association of abnormal meconium and fibrocystic disease of the pancreas. The first, advanced by Landsteiner, regards the abnormal meconium as primary and the

changes in the pancreas as the result of intestinal obstruction; the second considers the changes in the pancreas as primary and the abnormality of the meconium as the consequence of lack of normal digestion of the meconium by pancreatic secretions. The latter view, which is generally held at present, has been strongly supported by the studies of Farber.

Summary

1. Eight cases of meconium ileus are described. All of the infants presented signs of intestinal obstruction soon after birth and came to operation as soon as their disturbance of water and electrolyte balance had been corrected.

2. A new technique is described for the removal of obstructing meconium by irrigation through an ileostomy wound and milking out of bulky masses so as to re-establish the intestinal channel. Postoperative drainage is not required.

3. In 5 cases there was an associated volvulus of a loop of ileum, presumed to result from excessive writhing of elongated and hypertrophied coils of small gut proximal to the obstructing inspissated meconium. In 4 of these cases the volvulus was corrected by simple unwinding; in 1 case resection of gangrenous bowel was required; and in 2 cases failure to recognize the gravity of the circulatory impairment at the time of operation was a contributory cause of the unfavorable outcome.

4. In all 8 cases the existence of associated cystic fibrosis of the pancreas was established. The authors believe that pancreatic insufficiency underlies all instances of meconium ileus. The history of pancreatic fibrosis or of meconium ileus in a sibling supports the preoperative diagnosis of meconium ileus in a newborn infant with intestinal obstruction.

5. Five of the 8 patients coming to operation were successfully relieved of intestinal obstruction. The oldest of the survivors is now more than two years old. The prognosis of the survivors is dominated by the underlying pancreatic disease.—*Mary Frances Vastine, M.D.*

GENITOURINARY SYSTEM

ZATZKIN, HERBERT R. Effective compression in excretory pyelography. *Radiology*, May, 1948, 50, 639-644.

The author describes a method of technique in intravenous pyelography whereby he places

the cuff of a baumanometer beneath the customary compression band that is attached to most roentgenographic tables. The lower edge of the cuff is about 2.5 cm. above the symphysis with the tubes leading from the cuff directed inferiorly.

It is stated that the renal sinuses are better visualized, thus approaching the density of retrograde pyelography and that the resulting dilatation of the ureters and pelvis of the kidney is not objectionable.—*C. H. Warfield, M.D.*

BRODNY, M. LEOPOLD, and ROBINS, SAMUEL A. Urethrocystography in the male child. *J.A.M.A.*, Aug. 21, 1948, 137, 1511-1517.

Urethrocystography is a simple, painless and safe substitute for endoscopic examination which is applicable in many urinary problems in infants and children. A study of 250 male patients under sixteen years of age is reported by the authors.

The examination is indicated in suspected obstructive uropathy, persistent or recurrent pyuria, nocturnal and diurnal enuresis and other symptoms related to the lower part of the urinary tract, in the evaluation of postoperative results and in the study of physiology of micturition. Contraindications are urethral bleeding, acute local infections and recent instrumentation.

Two methods of study are employed: voiding and retrograde, the former depicting the physiologic state of micturition; the latter visualizing the anatomy of the urethra in a state of distention. The medium used is "rayopak" in 20 per cent dilution for cystography and 50 per cent for urethrography. For cystography the bladder is filled to tolerance and anteroposterior and oblique views are taken. In urethrography an oblique film is taken while the patient voids into a nonopaque plastic container. An anteroposterior view is also taken during a second voiding. Urethrogramms can be obtained similarly after excretory urography, and the authors recommend this as a routine procedure in children.

The retrograde method is performed by means of a special penile clamp with syringe, the exposure being made while the injection is in progress.

The anatomy and roentgenographic anatomy of the male urethra are described in the article.

The major pathologic conditions for which

the procedure is of value are classified in five groups: congenital anomalies, obstructive uropathies, infections, neuromuscular dysfunction and control of surgical status. Hypospadias, congenital stricture of the urethra, congenital valves, congenital fistulae and diverticulum and reduplication of the urethra are examples of congenital conditions amenable to diagnosis by this method. Of the obstructive uropathies, hypertrophy of the internal sphincter and inflammatory or traumatic strictures of the urethra and stricture of the external meatus are among the conditions observed commonly. In the group of infections, chronic cystitis may sometimes be diagnosed roentgenographically in the presence of negative urinary findings. Acute cystitis, urethritis and prostatitis have characteristic roentgen findings. In neuromuscular dysfunction the cystourethrogram is useful in localizing the involved muscular components. Finally, the procedure is useful in recording the anatomic and functional status following surgical treatment of the lower part of the urinary tract and in following the course of recovery.—*Leslie K. Sycamore, M.D.*

FISHER, R. S., and HOWARD, H. H. Unusual ureterograms in a case of periarteritis nodosa. *J. Urol.*, Sept., 1948, 60, 398-404.

Periarteritis nodosa involves the urinary tract in over 80 per cent of cases. The authors report a case occurring in a thirteen year old girl who was admitted to the hospital with a painful rigid abdomen, which relaxed a few hours after admission. Migratory joint pains developed two days later and persisted for several weeks. A maculopapular rash appeared on the extremities four days after admission. Chills and fever developed later. An intravenous urogram showed excellent concentration of dye in both kidneys. This dye was still present at sixty minutes. The upper thirds of both ureters were markedly dilated and spastic.

The symptoms recurred intermittently over a period of several weeks. An exploratory laparotomy showed an enlarged liver with spider-web like streakings in the capsule. Gradual abdominal distention, oliguria and elevation of the non-protein nitrogen occurred and were followed by generalized convulsions and death. Pathological examination showed an inflammatory and proliferative process involving the smaller arteries and arterioles of the kidneys, ureters and gallbladder. This vascular reaction

was most marked in the adventitial connective tissue of the ureters. The regional lymph nodes of the ureters were markedly hyperplastic. The anatomical diagnosis was periarteritis nodosa.

The authors feel that the ureterographic picture of moderate dilatation with marked spasticity is not found in other conditions and may be a specific finding in periarteritis nodosa.—*Rolfe M. Harvey, M.D.*

COTTLER, Z. R. Nonhormonal adrenal cortical carcinoma. *J. Urol.*, Sept., 1948, 60, 363-370.

Most of the emphasis has been placed on hormone-producing tumors of the adrenal cortex. The scarcity of reports on the nonhormone-producing tumors is due to their rarity, the absence of early symptomatology, and the confusion as to the primary site of a tumor when metastases are present due to the fact that carcinomas of other organs frequently metastasize to the adrenals.

Nonhormonal adrenal tumors are discovered late through the presence of a mass, vague abdominal pains, malaise, poor appetite and evidence of metastasis. The average duration of symptoms is one year and the tumors occur in adults over thirty.

Diagnostic aids include 17-ketosteroid urinary excretion studies, electrolyte and vitamin C balance studies, perirenal air insufflation, excretory urography and laminagraphy.

The treatment of the nonhormonal type of tumor has been surgical removal followed by high voltage therapy. The prognosis is poor.

The author reports the case of a fifty year old female who was admitted to the gynecological ward of the hospital for a "fallen womb." Abdominal palpation disclosed a large hard mass in the right flank, separate from the liver. The blood pressure was 290/170. Excretory urography showed depression and deformity of the pelvis and calyces of the right kidney. A barium enema showed extrinsic pressure effect on the right colon. A lateral pyelogram showed marked anterior displacement of the right kidney. A preoperative diagnosis of right renal neoplasm was made. At operation a tumor mass was found attached to the right kidney. Microscopic examination of the tumor was reported as adenocarcinoma of the adrenal. Following operation the blood pressure dropped to 136/76. Roentgen therapy, 2,500 r, was given postoper-

atively to each of our fields centered over the site of the lesion.

A recurrent mass was noted in the right mid-abdomen thirty months later and an additional 4,000 r was given to two fields. The mass was unchanged four months later and the same course of therapy was repeated. A recurrence in the left abdomen was noted five months later and deep roentgen therapy was given to this side of the abdomen. Mediastinal metastases were first noted thirty-nine months after operation. These were also treated by deep roentgen therapy, 1,500 r to an anterior and posterior field.

The remarkable points in this case are the maintenance of a normal blood pressure for five years following removal of the tumor, and the five year survival period with extensive abdominal and mediastinal recurrences which were present for at least twenty-seven months.—*Rolfe M. Harvey, M.D.*

KRETSCHMER, HERMAN L., and McDONALD, J.K. Carcinoma of the bladder with bone metastases; report of 8 cases. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 328-337.

The old idea that bone metastases secondary to carcinoma of the bladder are of rare occurrence seems still to prevail. In a previous communication one of the authors reported 5 cases and called attention to the fact that this condition occurs more frequently than is appreciated and that it may occur with small papillary tumors that appear to be simple papillomas.

Summary

1. Bone metastases in carcinoma of the bladder occur more frequently than is generally appreciated.

2. Papillary carcinoma was the type of tumor in each case in the authors' series.

3. In 1 case bone metastases were present although there was no evidence of bladder tumor at the time of entering the hospital.

4. In this series the type of bone lesion was osteolytic.

5. Bone metastases in bladder carcinoma occur reasonably early in the course of the disease.

6. It may be the cause of the first symptoms that bring the patient to the doctor.

7. Routine roentgen-ray examination in all

cases of papillary tumors of the bladder may reveal the presence of bone metastases when least suspected.—*Mary Frances Vastine, M.D.*

ROBINS, SAMUEL A., and FISCHMANN, JOSEPH. Hydronephrosis; radiologic classification based on anatomical variations. *Radiology*, May, 1948, 50, 632-638.

Anatomically hydronephrosis is classified as internal, combined or external according to its relationship to the kidney parenchyma. Internal hydronephrosis designates dilatation restricted to the intrarenal portion of the kidney and external hydronephrosis designates dilatation of the renal pelvis. The combined type involves both the calyces and the pelvis and is the most common type.

The width of the kidney parenchyma seen on the roentgenograms is a reliable index of the extent of damage resulting from the hydronephrosis.

The authors believe that the type of hydronephrosis and the measurement of the width of the renal parenchyma should be included in the roentgenographic report because this helps to describe the pathological anatomical process occurring within the kidney.—*Frank J. Rigos, M.D.*

SKELETAL SYSTEM

PONSETI, IGNACIO. Evolution and treatment of tuberculosis of the hip. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 257-276.

The evolution and the results of conservative and operative treatments were studied in 31 proved cases of tuberculosis of the hip followed for a minimum period of four years. This work was done in the Department of Orthopedic Surgery in the State University of Iowa Hospitals.

1. The first group of patients, all children, had a para-articular focus of tuberculous osteitis. In the granulous osteitis the roentgenograms show a small area of uniform bone destruction whereas one or several small bone sequestra are seen in the area of destruction due to caseous osteitis. Both types have a tendency to heal under prolonged conservative treatment. However, the hip joint in each of the 7 patients was invaded sooner or later by the tuberculous process.

The hip joint was slowly destroyed when lesions of tuberculous granulation tissue with no

year follow-ups with a resultant survival rate of only 4.1 per cent. This is regardless of the treatment used which included: surgery, irradiation and surgery, irradiation alone, and Coley's toxins. In discussing the distinguishing characteristics of this disease entity, the authors point out that Ewing's sarcoma is a disease of youth seen in males in a ratio of 2:1 with the majority of the primary sites below the waistline, often accompanied by fever and leukocytosis, and frequently diagnosed as osteomyelitis in its early phases. The origin of the tumor is stated to be in the medullary or subcortical portion of the bone, but this remains open to question as is brought out in the discussion. Pain, swelling and disability, the usual triad of symptoms with malignant bone tumors, are present in most cases. Metastases are early and widespread, involving bones, notably the skull, as well as the lungs. The authors stress that biopsies should be taken in all suspected cases before treatment as small doses of roentgen therapy may distort and mislead the histopathologic interpretation. The roentgen appearance of extensive involvement of the shaft with irregular cortical destruction and subperiosteal new formation with the "onion skin" appearance may be typical, but more often than not the appearance is atypical. The roentgen differential diagnosis includes osteolytic osteogenic sarcoma, reticulum cell sarcoma of bone, metastatic neuroblastoma, osteomyelitis, and occasionally eosinophilic granuloma. In this series pathological fractures are seen in 21 per cent of the cases and neurological disorder occurs in 16 per cent. The authors emphasize the extremely poor prognosis of this disease. As various methods of treatment have yielded uniformly poor results, the authors recommend palliation by roentgen therapy. The bibliography is well selected and comprehensive.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

SHERMAN, ROBERT S., and STERNBERGH, WALDEMAR C. A. The roentgen appearance of ossifying fibroma of bone. *Radiology*, May, 1948, 50, 595-609.

Twelve cases of ossifying fibroma of bone are reported by the authors. Six involved the maxilla, 5 the mandible and 1 the temporal bone. Pathologically ossifying fibroma of the jaw is not specific. The clinical and roentgenographic features are believed to be more characteristic than the pathological.

Clinically the disease occurs typically in childhood, being discovered as a painless swelling of the face which slowly enlarges over a period of months or years. In later life the growth rate slows down. Occasionally symptoms were present due to the growth effect of the tumor such as nasal obstruction, proptosis, tearing of the eye and deafness.

The best method of treatment is curettage of the tumor area. Resection of the tumor was done in a few of the larger tumors. Irradiation appeared to have little or no effect.

The roentgenographic findings are those of a unilocular lesion usually limited to the maxilla or mandible, oval to spherical in shape with a distinct boundary usually of an egg shell character. In the mandible the tumor arises within the medulla; in the maxilla the tumor may arise from the medulla or subperiosteally. In its early phase the process is predominantly osteolytic with little or no internal architecture and no periosteal reaction. Enlargement is progressive, with an increased productive element brought about in the maxilla by the formation of spherical densities and in the mandible by irregular striae. In the maxilla the adjacent bone may be dissolved without pressure displacement.

Several excellent illustrations are included.—*Frank J. Rigos, M.D.*

CAMP, JOHN D., and SCANLAN, ROBERT L. Chronic idiopathic hypertrophic osteoarthropathy. *Radiology*, May, 1948, 50, 581-594.

Chronic idiopathic hypertrophic osteoarthropathy, not associated with primary disease, is rather a rare condition. The authors report 5 cases and review 20 other cases reported in the literature. This disease occurs predominantly in males at the age of puberty or adolescence and is characterized by the osteoarthropathic syndrome—clubbing of the digits, enlargement of bones and joints and thickening of the skin of the face in the absence of any demonstrable primary disease.

Clinically the disease is slow and insidious in onset, with a slowly progressive course, which after many years gradually comes to a halt. Symptoms are few. Fatigue, excessive sweating and vasolability are common. Secondary sexual disturbances such as hypertrophy of the breast, feminine distribution of hair and scanty growth of the beard are also common. The joints may be involved with a real arthritis, a sterile effusion, pain, limitation of motion and systemic

reactions. The skin changes are due to increased fibrous tissue in the dermis and subcutaneous tissues. Large folds of skin are seen sometimes resembling gyri of the brain.

The striking roentgenologic feature is an accentuation of lateral growth in the bones symmetrically distributed and best seen in the long bones. Bone proliferates subperiosteally. The medullary cavity is not constricted. The proliferation is greatest over the diaphyses decreasing in extent to the epiphyses. The distal phalanges are usually not involved and the unguis tufts undergo absorption or atrophy. The bones are of normal length with normal epiphyses and joints. Secondary osteoarthropathy is the only disease which can cause an identical appearance. The acute onset, rapid progression and the association with the primary disease differentiates the secondary type from the chronic idiopathic variety.

The authors speculate about a possible relationship to the pituitary gland or to the hypothalamus. Treatment is symptomatic.—*Frank J. Riggs, M.D.*

FAIRBANK, H. A. THOMAS. Melorheostosis. *J. Bone & Joint Surg.*, Aug., 1948, 30-B, 533-543.

This article is taken from an Atlas of General Affections of the Skeleton and is the third in number. Subjects previously published were on osteogenesis imperfecta and osteopetrosis. Melorheostosis is a very rare condition in which certain bones or parts of bones are petrosed. It displays striking differences from generalized osteopetrosis or "marble bones." Fairbank briefly describes the distinguishing features as: (1) the changes, in typical cases, are confined to the bones of one limb; (2) the outline of an affected bone is, sooner or later, distorted; (3) there is often pain, occasionally severe, sometimes unbearable; (4) there is limitation of movement in the joints formed by the affected bones. None of these features is invariably present.

In the paper, the literature is briefly reviewed, followed by the etiology, age and sex incidence and the distribution of the petrosis. In more detail the symptoms and signs, the complications, roentgenographic appearance, progress, pathology and diagnosis are discussed. Brief case reports are given with the reproductions of the roentgenograms of the bone lesions.

Fairbank regards the diagnosis in a typical case as easy. In generalized osteopetrosis every bone is affected to some extent, and the distribution of the density in the individual bones differs markedly from that seen in melorheostosis. From osteopoikilosis the differentiation is also easy, provided that the whole roentgenographic evidence is considered and that undue attention is not paid to the appearance of one or two epiphyses. Other conditions to be differentiated are multiple diffuse fibrosis of bone (polyostotic fibrous dysplasia) and Albright's syndrome. No difficulty should be experienced in distinguishing the condition from inflammatory sclerosis.—*R. S. Bromer, M.D.*

FAIRBANK, H. A. THOMAS. Osteopoikilosis. *J. Bone & Joint Surg.*, Aug., 1948, 30-B, 544-546.

This paper is the fourth installment taken from an Atlas of General Affections of the Skeleton. Osteopoikilosis or osteopathia condensans disseminata is an unusual affection of the skeleton characterized by multiple dense spots in many bones. The age and sex incidence, roentgenographic appearance and distribution, the progress of the condition, complications, pathology and diagnosis are discussed. Roentgenograms of two cases are reproduced.

The dense spots, as described in the paragraph on the roentgenographic appearance, are circular, ovoid, or lanceolate, the long axis being parallel to the long axis of the affected bone. They vary in size between 2 and 10 millimeters. They occur in the epiphyses and adjacent parts of the metaphyses and are plentiful in the short bones of the carpus and tarsus. In most cases they are numerous and are found in every bone with the exception of the skull, ribs and vertebrae. Even in these bones, one or two spots have been seen, the skull being the most unusual site of all. The spots are in the cancellous bone and as a rule they are entirely free from the cortex which is never distorted in any way. Sometimes a spot of dense bone is prolonged into a short streak, in the axis of the bone, especially when it is situated some distance from an epiphyseal line where the metaphysis of a major long bone is passing into the shaft. In the shaft itself spots are seldom seen. Cases have been observed over a number of years with no apparent change in the roentgenographic appearances.—*R. S. Bromer, M.D.*

BLOOD AND LYMPH SYSTEM

BLEICH, ALAN R., and KIPEN, CHARLES S. Venous calcification in Banti's syndrome. *Radiology*, May, 1948, 40, 657-660.

A case history is presented in which the diagnosis of Banti's disease was made and the spleen removed seventeen years before the present admission.

On the present admission the roentgenogram showed a density running transversely across the upper mid-abdomen and lying behind and below the stomach in the region of the pancreas. Surgical exploration proved the density to be calcified splenic vein and portal vein. The case is presented for rarity in demonstrating calcified abdominal veins other than phleboliths.—C. H. Warfield, M.D.

WESTERMARK, NILS. Studies of the circulation by roentgencinematography. *Radiology*, June, 1948, 50, 791-802.

The author reviews some of the concepts of cardiovascular physiology and circulation time with particular reference to the fact that the ventricles do not empty by displacement of the apex and lateral contours of the ventricles toward the center of the heart but through displacement of the atrioventricular junction downward toward the apex. He reports from his previous investigations on the hearts of sheep that a metallic indicator placed at the atrioventricular junction made a sudden downward movement toward the apex. This movement began during or immediately after the QRS complex. About half way between the S and T the indicator made a rapid return to the original position which was reached at the beginning of T. From these experiments it appears that both the downward phase and the returning phase of the piston-like movement of the atrioventricular junction takes place during systole, while this junction remains relatively quiet during diastole.

The present report is based on studies of the circulation as recorded by cinematography of the fluorescent image produced by exposure to roentgen rays. An electrocardiogram has been taken simultaneously with the roentgen cinematography. A description of the equipment is given. The films show the contrast material (thorotrast) as it flowed through the heart (rabbit) and the rapid piston-like displacement of the atrioventricular junction toward the apex

and its equally rapid reverse movement is reported to have been demonstrated. The pulmonary circulation time as seen on the films varied between 1.2 and 2.5 seconds with a mean value of 1.5 seconds. Previous investigations showed the mean time of the entire circulation at approximately 18 seconds.

In interpreting the course of the systolic contraction it seems probable that the systolic contraction of the ventricle begins with a contraction of the interventricular septum, in which the septum is shortened and the central part of the atrioventricular junction drawn toward the cardiac apex. In connection with the contraction of the septum and the movement of the atrioventricular junction toward the apex, the papillary muscles emanating from the septum will contract and prevent the atrioventricular valves from being forced into the auricles. The contraction will then proceed continuously along the septum to the cardiac apex.—Robert K. Arbuckle, M.D.

ROENTGEN AND RADIUM THERAPY

PENDERGRASS, EUGENE P., and MAHONEY, J. FRANCIS. A consideration of roentgen therapy in producing temporary depilation for tinea capitis. *Radiology*, April, 1948, 50, 468-475.

Tinea capitis has been epidemic in the Eastern United States since 1943. The principal fungus is *Microsporum audouini*. The epidemiology, the usual clinical course of the disease and method of diagnosis are described.

Temporary epilation of the scalp by roentgen ray is the treatment of choice having demonstrated a very favorable percentage of cures.

In enumerating the advantages and disadvantages of roentgen treatment, the authors emphasize the safety of the procedure. It is a painless treatment performed at one sitting with a high cure rate. The patient becomes practically non-infectious at the end of three weeks. The possibility of permanent depilation is small and believed due to the disease rather than the effects of roentgen therapy.

Procedure—local treatment is discontinued for at least one week before roentgen depilation is undertaken. Hair is clipped short. A closed-portal technique individualized to varied head shapes is described. Technical factors are 75 kv. (peak), 18 ma., no added filter and a focal skin distance of 26 cm. Each field is

given 500 r (in air). This method of treatment has given a higher rate of cure than the previously employed Adamson-Kienböck technique.—*E. E. Seedorf, M.D.*

DONLAN, CHARLOTTE P. Tumor dose in cancer of the larynx. *Radiology*, April, 1948, 50, 463-467.

The author presents a classification for 113 cases of cancer of larynx treated at Presbyterian Hospital, New York. Reviews classification, technique and results of various authors showing that the tumor dose customary today is approximately 5,000 r. With some change in technique following 1928 to 1936 period, there has been little increase in the survival rate. Lesions restricted in the vocal cord gave the highest survival rate.—*E. E. Seedorf, M.D.*

NOHRMAN, BÉNGT A. Quelques expériences tirées de traitements du cancer du sein par rayons x associés à l'opération d'Halsted. (Some experiences drawn from treatment of cancer of the breast by roentgen irradiation combined with Halsted operation.) *J. de radiol. et d'électrol.*, No. 7-8, 1948, 29, 403-407.

This paper is from the Radiumhemmet, Stockholm, Service of Prof. E. Berven, and contains many wise precautions and statements essential to the correct discussion of the entire problem of therapy of breast cancer. Nohrman reports 769 cases of cancer of the breast treated at Radiumhemmet from 1936-1941. The cases were treated by irradiation combined with Halsted operation (radical mastectomy and dissection of axillary nodes). All patients were observed at least five years and the tumor tissue subjected to rigid microscopic study. The author shows that a clinical classification of Steinthal's type is not adequate; the best classification is based on the histopathological examination of the axillary nodes. The cases of this compilation have been classified according to these principles. The importance of different factors is discussed: degree of extension of axillary metastasis, age and death from intercurrent disease, menopause, selection of cases, roentgen treatment before and/or after operation. He concludes that preoperative roentgen treatment makes the prognosis better in the group which comprises the cases with the worst prognosis (15 per cent of all cases). As it is impossible to decide with certainty before

the operation to which group or which stage the cases belong, every patient suffering from cancer of the breast should be given preoperative irradiation. Lastly, the value of postoperative irradiation can be considered as firmly established.—*William M. Loehr, M.D.*

MAISIN, J. Le rôle des radiations dans le traitement du cancer du sein. (The rôle of irradiation in the treatment of cancer of the breast.) *J. de radiol. et d'électrol.*, No. 7-8, 1948, 29, 363-400.

The purpose of this report is to evaluate treatment of cancer of the breast by irradiation as an adjunct to surgery and treatment of breast cancer by irradiation alone. The author is Director of the Cancer Institute at the University of Louvain and this article was the second report presented before the VI Congress of French-Speaking Radiologists held at Geneva, July 27-31, 1948.

In his Avant-propos the author shows the necessity of revising classical notions on the treatment of carcinoma of the breast.

He then gives a detailed analysis of surgical statistics. This is necessary from the fact that Halsted's surgical treatment has been the classical treatment of carcinoma of the breast for the last fifty years. According to this investigation cancers of Stage I Steinthal have good surgical results; 65 per cent cases of survival after five years can be considered the figure. For Stage II cases surgical results after five years are mediocre, 25 per cent is an average number. It must be noted that Stage II carcinoma is much more frequent than Stage I. The average survival of Stage I and Stage II cases is 35 per cent.

It seems logical, then, to look for better results in a surgical-irradiation combination or in irradiation alone.

Postoperative radiotherapy has been more frequently employed than preoperative, or the two combined. Postoperative radiotherapy distinctly improves surgical results, particularly in cases of Steinthal's Stage II, in which survival after five years is almost doubled.

In Stage I cases, results are improved, but this is difficult to prove owing to the high percentage of survivals due to surgery only. For both Stage I and Stage II the average survival after five years is 50 per cent.

The Edinburgh school strongly recommends mastectomy followed by postoperative irradiation.

tion (50 per cent after five years, Stage I and II).

The combination of roentgen irradiation with wide radium puncture without other surgical interference than a biopsy gives almost equal results as postoperative radiotherapy (51 per cent after five years). Steinthal's Stage IV cases give only palliative results. Survivals after five years are rare.

The value of hormone therapy and castration as contributing factors to other treatments is discussed.—*William M. Loehr, M.D.*

THAYSSSEN, VIGGO E. The influence of castration by roentgen on carcinoma of the breast. *Acta radiol.*, 1948, 29, 189-204.

The author presents material from the Radium Center in Copenhagen which consisted of 99 breast cancer cases with metastases or recurrences. All of these cases were treated with roentgen irradiation of the ovaries and in one-third improvement resulted. A comparison with 100 control cases which were not subjected to castration therapy shows that 40 per cent of the castrated were still living two years after the appearance of the metastases as against only 11 per cent of the controls. Of 74 pre- or postoperatively roentgen treated and castrated, 28 per cent were alive five years after the operation as against 8 per cent of the controls. On the basis of 79 urine assays for gonadotropin and estrogen it is shown, among other things, that the castration may have a highly beneficial effect even in cases where the estrogen output was low before castration.—*Mary Frances Vastine, M.D.*

LEWIS, LLOYD G. Radical orchiectomy for tumors of the testis. *J.A.M.A.*, July 3, 1948, 137, 828-832.

The author bases his treatment of testicular tumors on their radiosensitivity as determined by Friedman,* and in line with this he offers a clinical-pathologic classification. After simple orchiectomy, the tumor can be accurately classified and the proper selection of treatment made. This is either irradiation, extended surgical treatment or combined therapy.

The seminoma comprises 44 per cent of the 250 cases, and is characterized by relatively slow growth, late but inoperable metastases and marked radiosensitivity. About 1,000 roentgens are necessary for prophylactic or

definitive therapy. Treatment is thus logically taken care of by simple orchiectomy followed by postoperative irradiation with 1,000 roentgens delivered to the nodes.

The tumors of definite embryonic cells, undifferentiated or adenocarcinoma, comprise 11.27 per cent of the series, and are characterized by rapid growth, early metastases and sensitivity to irradiation somewhat less than the seminoma since a dose of 2,000 or 3,000 roentgens is necessary to destroy this group. Orchiectomy followed by 250,000 volt roentgen therapy is inadequate and radical resection of the retroperitoneal nodes is done.

The presence of chorionic tissue distinguishes two related groups of tumors. The trophocarcinoma developing from the cytotrophoblast comprises 6.8 per cent and the chorionepithelioma from syncytiotrophoblast comprises 4.8 per cent. These are the hemorrhagic tumors which metastasize by way of the blood stream as well as the lymphatic system and are radio-resistant, requiring 5,000 to 6,000 roentgens for destruction. Prophylactic irradiation is therefore contraindicated and radiation therapy confined to inoperable metastatic involvement.

The remaining tumors are made up of various types of teratocarcinomas; the exact type depending on whether the malignant cells take the form of seminomas, embryonal carcinomas, choriocarcinomas, chorionepitheliomas or the form characterized by malignant change in the undifferentiated tissue itself. In all these tumors, however, there are either adult or embryonic structures derived from more than one primitive germ layer. They are cystic and may be recognized on gross examination. They are very radioresistant.

A description of the operative procedure of resection of the retroperitoneal nodes is given. This procedure is advocated either with, or in the cases of the very resistant tumors, without associated roentgen treatment for all malignant tumors of the testicle except the seminoma. There was no operative mortality in 169 cases.—*F. H. Squire, M.D.*

MUSGROVE, JAMES E., and McDONALD, JOHN R. Extra-abdominal desmoid tumors. *Arch. Path.*, April, 1948, 45, 513-540.

The authors define desmoid tumors as usually solitary benign fibrous neoplasms originating from musculo-aponeurotic structures and having the peculiar characteristic of locally invad-

* Friedman, M. S. *Clin. North America*, 1944, 24, 1424.

ing striated muscle. They occur most frequently on the abdominal wall.

This paper is a clinico-pathological study of 34 cases of extra-abdominal desmoid tumors removed surgically at the Mayo Clinic in the thirty-eight years through 1945. The tumor occurs in a wide age distribution predominantly (70 per cent) in females. The authors discuss the traumatic and endocrine theories of etiology and elaborate extensively on the pathological features.

Radical excision is the treatment of choice. Recurrence follows incomplete removal. The tumor is almost completely radioresistant. The authors feel that if irradiation is used at all it should be used in cancerocidal doses. Castration or other endocrine therapy may be helpful in inoperable cases.—*D. D. Beiler, M.D., and C. L. Hinkel, M.D.*

SCHMITZ, HERBERT E., and TOWNE, JANET E.

The treatment of pelvic endometriosis. *Am.*

J. Obst. & Gynec., April, 1948, 55, 583-590.

One hundred thirty patients with pelvic endometriosis have been studied and divided into four groups according to the method of treatment. These groups are: (1) surgical group, (2) irradiation group, (3) hormone group, and (4) untreated group. Some of these patients are included in more than one group. They have been followed from one to four years.

Since pelvic endometriosis occurs most frequently in the child-bearing period and is a major cause of sterility, conservative treatment which will increase the possibility of conception is desirable. Forty-three and nine tenths per cent of the 130 cases treated were treated by surgical procedure. Ten, or 17.6 per cent, required radical surgery. Forty-seven, or 82.4 per cent, had one or both ovaries preserved, and 11 later conceived, giving birth to 13 infants. Roentgen therapy was used in 29 cases, of which 17 were given sufficient dosage to cause permanent menolysis. Twelve were treated with smaller dosage causing a menolysis of from three to eight months. In this group 2 conceived and delivered 3 infants, an incidence of conception of 16.6 per cent. Roentgen therapy in this group proved satisfactory for secondary therapy when conservative surgery had failed. Roentgen therapy of sufficient intensity to destroy ovarian function is indicated in cases where endometrial tissue has

invaded bowel or bladder. It obviates the necessity of surgical resection with its increased risk.

Watchful expectancy or male hormone therapy is of value in cases with minimal disease and symptoms in young women. It enables one to postpone more radical procedures to the years when such therapy is less costly.—*Wendell C. Hall, M.D.*

BRUNSCHWIG, ALEXANDER. Complete excision of pelvis viscera for advanced carcinoma. *Cancer*, July, 1948, 1, 177-183.

Brunschwig describes a radical operative procedure for total excision of all pelvic viscera which has been carried out on 22 patients with advanced carcinoma. Most of these had received irradiation previously without control of the growths. Many had pain, fistulas, and ureteral involvement. No selection of cases was made except that the disease must be confined to the pelvis.

After thorough preoperative preparation, the bladder, lower ureters, pelvic colon, uterus and adnexa, including contents of obturator fossae, are mobilized through a low midline excision. A sigmoid colostomy is done and both ureters are transplanted into the sigmoid. A perineal approach is then made to remove these viscera with complete resection of the vagina and anus. The resultant "wet colostomy" is handled by a Rutzen bag cemented to the skin.

The primary operative mortality was 23 per cent. It is not claimed that this operation is more than a palliative procedure although several patients are living without evidence of disease four to eight months later. They returned to normal physical activity. This is attained despite the fact that all patients were in terminal stages of disease prior to operation, and presented the usual criteria of inoperability.—*J. A. Campbell, M.D.*

MILLER, NORMAN S. Carcinoma of the uterus, ovary and tube. *J.A.M.A.*, Jan. 17, 1948, 136, 163-169.

Discussion of the management of cancer of the female generative organs is based on experience with 100 per cent follow-up of almost 2,500 patients during the past fifteen years at the University of Michigan Gynecological Tumor Conference.

Sixty-five per cent of all cancers of the female generative organs arise in the uterine cervix.

The advanced state of these cancers when first seen is assessed chiefly to (a) the underdeveloped program of periodic health examinations and (b) delay on the part of patients in seeking medical advice after the onset of symptoms. The chance of cure decreases approximately 16 to 20 per cent per month after the onset of symptoms (spotting). Cervical cancer is 90 per cent epidermoid, and 10 per cent adenocarcinoma which spreads chiefly by direct continuity or through the lymphatics, occasionally obstructing the rectosigmoid or metastasizing to bone. Death frequently results from ureteral stenosis, and less commonly from pulmonary metastases and infection. The principal and commonly only symptom of cervical cancer is irregular spotting or bleeding. Diagnosis should be proved by biopsy in every case.

Miller states that clinical grouping is the most important single factor in determining prognosis. The two acceptable treatments for cervical cancer are (1) irradiation by high voltage roentgen rays and radium, and (2) radical hysterectomy of the Wertheim type with bilateral salpingo-oophorectomy and pelvic lymphadenectomy. The latter is confined only to selected cases and there is not yet sufficient evidence that such surgery has more to offer than properly applied radiation.

Endometrial adenocarcinoma of the uterine corpus constitutes 15 per cent of all genital tract cancers. Clinical grouping is less satisfactory than in the cervix and is based on size of uterus, parametrial extension, and degree of uterine fixation. Postmenopausal spotting is the commonest symptom with 25 per cent showing only semipurulent leukorrhea, and 5 per cent no symptoms. Diagnosis may be suspected or proved by cytologic smears. The definite proof of malignancy and origin of such cells should come from uterine curettage, more dependably done in a hospital under anesthesia. Advanced cases permit no choice of treatment than high voltage roentgen radiation plus multiple capsule intrauterine application of radium which may result in cure. This method is also used in early cases whose health precludes major surgery. In all other cases, external irradiation or intrauterine radium is followed in six to eight weeks by total hysterectomy and bilateral salpingo-oophorectomy to remove any remaining active neoplastic cell nests.

Ovarian carcinoma amounts to 10 to 20 per

cent of the total, affects chiefly postmenopausal women, and escapes early detection except by periodic pelvic examination. The degree of malignancy varies from the fast growing teratomatous to the slow growing papillary cyst adenocarcinomatous types. Diagnosis rests on cytologic study of ascitic fluid or histopathologic analysis of a surgical specimen. Solid ovarian masses or cystic enlargements of more than 5 cm. size, especially if showing progressive growth, call for surgical removal. Hysterosalpingo-oophorectomy is recommended for proved cases. Preoperative or postoperative roentgen therapy is desirable in all but extremely early lesions in young women in whom a normal ovary is left. Such therapy may make the lesion operable or occasionally may prolong life a decade or more.

Fallopian tube neoplasms account for only 0.1 per cent of genital cancers and are of the papillary adenocarcinoma type. Secondary carcinoma of the tube may occur from primary ovarian or uterine cancer. Diagnosis is made from cytologic smear, biopsy through the cul-de-sac or laparotomy following the discovery of a firm or nodular movable mass in the tubal area. Treatment consists of surgical extirpation of both tubes, ovaries, and uterus in operable cases. Roentgen therapy is given postoperatively and in inoperable cases.—*J. A. Campbell, M.D.*

DIDDLE, A. W., and BENNETT, T. R. Carcinoma of the cervix in an urban population. *Am. J. Obst. & Gynec.*, April, 1948, 55, 669-675.

This article deals with experience in treating cervical carcinoma in Dallas, Texas between Jan. 1, 1936 and Jan. 1, 1946. Data for this study were obtained from metropolitan hospitals, private radiologic clinics, and the Registrar of Vital Statistics of the City of Dallas. Some of the records were very incomplete. Valuable information was also obtained from four of the pathology laboratories in the city. Data were obtained for 1,134 women with carcinoma of the cervix, probably representing at least 90 per cent of the new patients seen with cervical cancer in the city during the ten year period. Succeeding discussion is based on 992 women for whom the histopathologic diagnosis was available.

One-third of the women in the group were referred from smaller communities in Texas, Arkansas, Louisiana, and Oklahoma while th

other two-thirds lived in the city. An equal number of women were in the pre- and post-menopausal period. Eighty per cent were white and the remainder Negro or Mexican. Five per cent of the women were under thirty years of age. The youngest patient was nineteen and the oldest was eighty-seven years of age.

Most of the women sought consultation for vaginal bleeding or leukorrhea. It is impossible to correlate the duration of symptoms with the clinical grade of the tumor. The average delay from the onset to the time a diagnosis was made was 7.14 months; 6.4 wasted by the patient and 1 by the physician.

Sixty of the patients had adenocarcinoma and 932 epidermoid carcinoma. Fifty-seven were Stage I (Schmitz classification), 171 were Stage II, 302 were Stage III, 174 were Stage IV, and 290 were unclassified. Five hundred and thirty patients were treated with roentgen rays and radium. Eighty-nine had total hysterectomy and irradiation. (Sixty of the total hysterectomies were performed after cancer was suspected and the other 29 were done without suspecting cancer.) Subtotal hysterectomy and irradiation were used on 99 cases. Other gynecologic procedures and irradiation were used in 10 cases. Treatment information was incomplete in 264 cases. The use of both roentgen rays and radium gave better results than either alone or in combination with total hysterectomy. The prognosis for those women who developed cancer in the cervical stump after subtotal hysterectomy was almost as good as for those who had cervical carcinoma with the fundus present. The survival rate was decidedly diminished for those who originally had a subtotal hysterectomy for unsuspected cancer probably because of two factors: more time was wasted in giving proper treatment and the growth of the tumor was aggravated. Radiation treatment gave as satisfactory results for adenocarcinoma of the cervix as for epidermoid carcinoma. Nearly one-fourth of the women traced had known sequelae, exclusive of pain, attributed to the malignancy or to the treatment. Sequelae were about 50 per cent more common among patients having pelvic operations than among those who were unoperated. This relationship was particularly true where extrapelvic metastases and local recurrence with vaginal hemorrhage developed. Vaginal fistulas were three times more common among women who were irradiated repeatedly than among those

given only one course of treatment.—*Wendell C. Hall, M.D.*

MARKS, JOSEPH H., and WITTENBORG, MARTIN H. Results of treatment of carcinoma of the ovary with data on the age incidence of this disease. *Surg., Gynec. & Obst.*, Nov., 1948, 87, 541-545.

A review of the literature on malignant epithelial tumors of the ovary leaves some doubt as to the value of roentgen therapy in this disease. Most of the previously reported series of cases show little if any benefit as a result of such therapy. Most authors have recommended that roentgen treatments be given as a palliative measure in the more advanced cases. They have admitted that the dosage given to many of the patients was less than optimum as judged by present standards.

The authors report a series of patients seen in the department of roentgenology of the New England Deaconess Hospital during the ten year period beginning in June, 1936. The series consists of 76 patients, 57 of whom have now been followed to death. Of the original group, 14 were alive more than five years after their first operation and treatment, but 3 of the 14 have since died of their disease. One is alive at five and a half years with recurrent disease. Not all of the patients have as yet had an opportunity to live five years after treatment, but the five year survival rate calculated by the method of Nathanson and Welch is 21 per cent.

The original plan of treatment called for 1,800 roentgens (measured in air) to each of four pelvic ports. Treatments were given at 400 kilovolts with 50 centimeter target to skin distance and with a filter of 0.9 millimeter tin, 0.25 millimeter copper, and 1.0 millimeter aluminum. The usual daily dose was 300 roentgens to a single port and treatments were given daily except Sundays.

Conclusions.

1. Roentgen therapy should be employed in *all* cases of carcinoma of the ovary. This therapy is excellent insurance postoperatively even when the surgeon believes that all disease has been removed. Occasionally it may result in cure even in advanced stages of the disease.

2. The surgeon should not take too great risk in his attempt to remove the last fragments of diseased tissue. He should remove the easily accessible masses and then rely on roentgen

therapy in adequate dosage and through whatever ports may be necessary to cover the involved areas.

3. Roentgen therapy may bring about gratifying palliation even when cure is not obtained. It often gives relief of pain and causes a retardation of the production of peritoneal and pleural fluids.

4. The age specific incidence of cancer of the ovary is unlike that of most other types of malignant epithelial tumors since it falls after the sixth decade.—*Mary Frances Vastine, M.D.*

CAHAN, WILLIAM C., WOODARD, HELEN Q., HIGINBOTHAM, NORMAN L., STEWART, FRED W., and COLEY, BRADLEY L. Sarcoma arising in irradiated bone; report of eleven cases. *Cancer*, May, 1948, 1, 3-29.

The authors have analyzed the literature, both laboratory and clinical, and come to the following conclusions: that the production of sarcoma in bone following irradiation is an uncommon sequel, which may take place whether normal or abnormal bone has been irradiated; whether malignant or benign lesions have been irradiated; that 3,000 roentgens are probably required to produce this change; that the malignant change requires from five to twenty-five years to take place. No explanation is given for the infrequent development of sarcoma in ribs, maxilla and jaw other than the possibility that these patients have malignant diseases from which they die before an observation of developing sarcoma is made.

It is believed by the authors that this complication of irradiation will become progressively less common as more radiologists restrict their activity to malignant diseases of bone. Particular attention is drawn to the inherent tendencies of giant cell tumors to undergo malignant changes, and it is the authors' opinion that roentgen radiation, an agent that in itself may provoke malignant changes, should not be used.—*W. E. Childs, M.D.*

CRAVER, LLOYD F. The nitrogen mustards; clinical use. *Radiology*, April, 1948, 50, 486-493.

The history of discovery of usefulness of nitrogen mustards is given. Particularly subject to damage are the lymphoid tissues of the thymus, spleen, and lymph nodes, the bone marrow and the intestinal mucosa. Drug most

widely used and employed by author is methylbis (beta-chloroethyl) amine hydrochloride. The method of use is described. With continued experience, dosage has increased now consisting of 0.2 mg. per kilogram body weight given intravenously on two or three successive days. Dosage is guided by total white blood cell count which decreases after administration.

Local toxic effects are occasional thrombosis and, if a leak into surrounding tissues, local inflammation. General toxic effects are mainly nausea and vomiting.

None of the nitrogen mustards have shown ability to cure any type of cancer. Palliative results have been seen in generalized Hodgkin's disease with marked constitutional symptoms, advanced cases of lymphosarcoma and anaplastic carcinomas of the lung.

In early and intermediate stages of Hodgkin's disease, in most cases of lymphosarcoma, and in most cases of chronic leukemia, it seems doubtful that nitrogen mustard offers any advantage over roentgen therapy.—*E. E. Seedorf, M.D.*

BURCHENAL, JOSEPH H. The newer nitrogen mustards in the treatment of leukemia. *Radiology*, April, 1948, 50, 494-499.

Originally most widely used nitrogen mustard was methyl bis (2-chloroethyl) amine hydrochloride, known as HN2. Author reports experience with new nitrogen mustard derivative, 1:3 propane diamine NNN'N' tetrakis-(2-chloroethyl) dihydrochloride, known as SK 136. Administration is 0.1 mg. per kilogram of body weight daily for four to eight doses. New drug produced less nausea and vomiting among patients with chronic myelogenous leukemia, but patients with Hodgkin's disease had as much or more nausea as when HN2 was used.

Another derivative, SK 137, was discontinued because of increased toxic effect with no offsetting advantage. As with all other known forms of therapy, patients with chronic myelogenous leukemia progress from a state of sensitivity to treatment to one of resistance. Treatment of acute leukemia is unsatisfactory. SK 136 may be valuable in some patients which have become refractive to roentgen therapy and some in which the liver and spleen is of normal size. In general, roentgen therapy is more versatile and more effective.—*E. E. Seedorf, M.D.*

RADIOISOTOPES

WRIGHT, H. P., OSBORN, S. B., and EDMONDS, D. G. Rate of flow of venous blood in the legs measured with radioactive sodium. *Lancet*, Nov. 13, 1948, 2, 767-769.

The author describes a direct method of measuring the rate of venous blood flow in the leg using a radioactive isotope Na^{24} and a Geiger-Müller counter recording on a kymograph drum.

In 121 normal people the mean foot-groin flow time was 18 ± 0.9 sec. The range was 4-50 seconds.—*J. S. Summers, M.D.*

ROWLANDS, S., ROWLEY, D., and STEWART, H. D. Absorption and excretion studies with radioactive penicillin. *Lancet*, Sept. 25, 1948, 2, 493-495.

Urinary excretion studies were carried out in female cats using penicillin labelled with S^{35} . Intramuscular injections gave rise to a urinary excretion of 100 per cent of the radioactive sulfur isotope, but there was a much smaller recovery of penicillin.

Oral administration gave much less excretion. The amount of radioactivity remaining in the gut at the end of the experiment suggested that non-absorption would account for that not present in the urine.—*J. S. Summers, M.D.*

SMITH, ROBERT E., and BRONSON, JOHN F. An improved radioactivity measuring cup. *Science*, June 4, 1948, 107, 603.

The authors describe the manufacture of a specimen cup used for the measurement of radioactivity in samples of either biological or chemical origin. A solution containing the active isotope is placed in a plain sample cup obtained commercially and which is stamped by a die of tool steel to give the desired concentric circular embossments.

Sample cups of the design reported here have been successfully used by the authors in measuring P^{32} , I^{131} and C^{60} . C^{14} or S^{35} have not been studied.—*Anthony F. Rossitto, M. D.*

MISCELLANEOUS

EPSTEIN, BERNARD S. Laminagraphy through plaster casts in postreduction roentgenography of congenitally dislocated hips. *J. Bone & Joint Surg.*, July, 1948, 30-A, 778-780.

Epstein advocates the use of the laminagraph

to secure better detail in roentgenograms of patients with congenital dislocation of the hips following reduction. Overexposed roentgenograms, taken with the use of the Potter-Bucky diaphragm, in his experience have been for the most part inadequate. The alignment of the hips cannot be adequately seen through the plaster casts.

The technique used is 150 milliampereseconds, 55 to 60 kilovolts, target-film distance of 30 inches and Par Speed screens. The Kieffer laminagraph is employed using a five-turn spiral motion. Sometimes the five second exposure is too long for the patient to keep quiet, but, if the examination is performed while the child is anesthetized, this difficulty may be overcome. Otherwise, a two second exposure with two spiral turns is made, the kilovoltage or milliampereseconds being raised to compensate for the diminished exposure.

He advises a preliminary roentgenogram based on an estimation of the height of the hips from the table top. Inspection of the wet film will determine whether or not the proper plane is in focus, and succeeding exposures can be made, as necessary. In his experience, the hips of infant patients were usually brought into sharp focus at 4.5 to 6 cm. from the table top. Occasionally, the femora will be so fixed that they are in slightly different planes. Separate exposures are then required, each thigh being placed so that the hip and femur lie parallel to the cassette. Attendants holding the patient should wear rubber gloves for protection.—*R.S. Bromer, M.D.*

JACOBSON, L. O., MARKS, E. K., GASTON, E. O., SIMMONS, E. L., and BLOCK, M. H. Studies on radiosensitivity of cells. *Science*, March 5, 1948, 107, 248-250.

Experiments performed tend to show that erythroblast vulnerability to irradiation injury is not enhanced by increased mitotic activity and proliferation. In fact, the hyperplastic erythroid tissue sustained less histologic injury than the normal. This is in contradistinction to the common belief that the more active the proliferation the more sensitivity to irradiation.

Whole body roentgen irradiation, 800 r, was applied to normal rabbits and those in which increased erythropoiesis was induced by phlebotomy or by the hemolytic action of acetyl phenylhydrazine on the circulating erythrocytes. In the former, the erythropoietic tissue

in bone tissue and spleen was essentially destroyed completely, but in the latter only partially destroyed.—*Anthony F. Rossitto, M.D.*

MURPHY, J. B., and STURM, E. The effect of growth or retrogression of a transplantable lymphosarcoma of the rat on the lymphoid organs and the adrenals of the hosts. *Cancer Research*, March, 1948, 8, 139-142.

Investigation shows that the weight of the thymus, lymph nodes, and spleen in rats with actively growing transplanted lymphosarcoma is reduced. On the other hand, these organs increase in weight in rats with regressing transplanted lymphosarcomas. The adrenals of rats with progressing tumors were found to be about 25 per cent above normal weight while the adrenals in rats with regressing tumors was found to be about 30 per cent above normal weight. The reason for the above described changes cannot be clearly explained.—*John DeCarlo, Jr., M.D.*

SKAGGS, L. S., ALMY, G. M., KERST, D. W., and LANZL, L. H. Development of the betatron for electron therapy; with an introduction on the therapeutic principles of fast electrons. *Radiology*, Feb., 1948, 50, 167-173.

Originally used for treatment of superficial skin lesions in 1928, the cathode ray, or electron stream, is again being investigated as higher voltage generators have increased the penetration possible. The betatron is the best method yet devised.

Unlike roentgen rays or gamma rays, the damage to normal tissue is not the limiting factor in their use on deep-seated lesions. The concentration of energy in a beam of fast electrons is at the end of the beam, not at the source. The beam range is limited by the voltage used in producing it. Therefore, one can concentrate the energy in the tumor, not in the surrounding or overlying tissues.

In this work a 22 million volt betatron at the University of Illinois was used.

The betatron accelerates electrons by injecting them into a circular vacuum chamber, called a donut, between the poles of an alternating current electromagnet. As they reach acceleration, the diameter of the electron orbit

is expanded. A magnetic shunt is then used to deflect them out of the field and into the emerging stream. At a distance of 1 meter, an ionization equal to 100 r per minute of roentgen rays was produced. At 35 cm. an ionization of 1,500 r per minute with an 8 sq. cm. field was observed.

The beam measures 2.6 mm. as it emerges. Through air, the beam measures 6×13 at 10 cm., and 2×4 cm. at 35 cm. distance. Through a vacuum the beam remains smaller and much better defined.

A 13 mev. stream showed a penetration of 6 cm. through presdwood and it is calculated that a 35 mev. beam will penetrate 17 cm.

Ionization has not yet been measured, but it is expected to show slight increase from the surface to a point near the end of the range, with a sharp decrease to near zero, the exit dose being very small.

Collimation of the beam is simple, using wood and plastics.—*George D. Adams, M.D.*

SHULL, C. G., and WOLLAN, E. O. X-ray, electron, and neutron diffraction. *Science*, July 23, 1948, 108, 69-75.

Neutron diffraction, the newly developed field in studying the atomic, molecular and crystalline structures, apparently has advantages in some problems over the older fields of roentgen-ray and electron diffraction.

Simple examples of such determinations have been carried out and charts and photographs are included in the paper. The most important applications were connected with the location of hydrogen or deuterium positions.

From studies made there seems to be no serious obstacle in the way of extending the technique to more complicated cases, especially where deuterated compounds can be used. It may become a useful tool in the study of the structures of organic compounds.

Since complicated structure determinations are very time consuming, rapid progress cannot be expected. Furthermore, the requirement of a chain-reacting pile as a source will make progress slower than by roentgen-ray and electron diffraction, for which adequate sources can be procured by any laboratory.—*Anthony Rossitto, M.D.*





CHARLES L. MARTIN

Janeway Lecturer, 1949

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 62

OCTOBER, 1949

No. 4

LOW INTENSITY RADIUM ELEMENT NEEDLES

JANEWAY LECTURE, 1949*

By CHARLES L. MARTIN, M.D.

DALLAS, TEXAS

IT is my privilege today to pay tribute to two great men—Henry Harrington Janeway in whose honor this lecture was conceived and Gordon Richards who except for his untimely passing would now be standing before you. It was not my good fortune to know Dr. Janeway but the stimulating friendships and generous co-operation accorded me by the small group of scientists who worked with him and were inspired by his genius have placed me forever in his debt.

Gordon Richards was a personal friend blessed with the natural ability and wide experience which made him one of the world's top-ranking radiotherapists. A Janeway Lecture detailing his ingenious techniques and reviewing his voluminous, carefully kept records would have far surpassed anything that I can possibly present to you.

In casting about for a subject worthy of this occasion I have, with some misgivings, elected to discuss the trials and tribulations of a lone individual intent upon developing a worthy type of interstitial radium therapy at a great distance from the large, well equipped radiation centers. Interstitial radium provides the most efficient medium

for the delivery of a given biological effect in an accessible tumor and it is not surprising that Alexander Graham Bell writing to Dr. Zowers⁴⁴ in 1903 stated: "but there is no reason why a tiny fragment of radium sealed up in a fine glass tube should not be inserted into the heart of a cancer, thus acting directly upon the diseased material."

In 1916 Failla succeeded in sealing radon into fine glass capillary tubes and Quick³⁸ states that the work done with such implants from 1917 to 1925 at the Memorial Hospital "went a long way toward eliminating the fallacious surface applications then so universally employed and in calling attention to the ultimate possibility of interstitial irradiation." The severe caustic reaction produced by the glass radon seed aroused much criticism, and in 1924 Failla perfected a method for sealing radon into tiny gold tubes which provided sufficient filtration to eliminate much of this untoward reaction.

My first radium therapy was carried out in 1920. Since I lived at a great distance from New York, radon seeds were not made immediately available and only radium element needles could be obtained for interstitial work. At that time most of the

* The fourteenth Janeway Lecture, delivered at the Thirty-first Annual Meeting of the American Radium Society, Atlantic City, N. J., June 5-7, 1949

standard needles provided by the manufacturers contained relatively large amounts of radium and had steel walls which filtered out only a portion of the irritating beta rays. In such resistant structures as the uterine cervix they were used with some success, but the sloughs and painful reactions produced in intra-oral lesions made this work most unsatisfactory and I finally decided to abandon interstitial needle therapy altogether.

An address delivered before this Society by Prof. Claude Regaud⁴¹ of Paris, France, in 1924 renewed my interest. He made it obvious that the needles at my disposal were incorrectly designed and that my methods were not based on sound principles. Among other things he stated that "Radium therapy should employ ultra-penetrating gamma rays filtered by heavy metals as recommended by Dominici in 1907" and that "generally the treatment is most effective if continuous and extended over 6 to 10 days."

In a paper presented before our Society in 1925 Lenz¹⁵ described the technique carried out at the Radium Institute in Paris with platinum-iridium needles containing 0.66 to 1.0 mg. of radium per centimeter of active length, but many of the prominent radiologists who took part in the discussion condemned radium needle therapy, probably because their experience had been similar to my own. Although I was convinced that interstitial radium therapy should form a valuable part of our armamentarium, this discussion left me uncertain and somewhat confused, and this state of uncertainty prevailed until 1927 when a preliminary report on the use of low intensity needles in the treatment of cancer of the tongue at the Westminster Hospital in London by Evans and Cade¹⁰ was brought to my attention. Beautiful colored drawings were used by the authors to show complete regressions of cancers of the tongue produced without painful reactions. Much of this work was done with small platinum needles containing only 0.6 mg. of radium. Here then was a practical, inexpensive procedure which could

be carried out by a radiologist with modest equipment located in a part of the world where radon seeds were not available.

In a small book entitled "Radium Treatment of Cancer" published by Cade³ in 1929, low intensity radium needles were described in some detail and practical techniques for their use in various parts of the body were outlined. The author stated that he made free use of the teachings of the Curie Foundation in Paris and the Radium Institute in Brussels and it was obvious that the low intensity needle which he described fulfilled the requirements of Regaud. Implantations of intra-oral lesions with small 0.66 mg. needles were first carried out in our Clinic in 1930. It became evident at once that the reactions were much milder and healing much more prompt than with the older types of steel needles.

TYPES OF RADIUM NEEDLES

If radium needles are to be left in the tissue for periods of six to ten days it is essential that the filtration be sufficient to remove all of the beta rays and that not more than 1.0 mg. of radium, and preferably less, be placed in each centimeter of active length. Cade⁴ states that most of the needles now used in his clinic contain 0.66 mg. or 1.0 mg. per centimeter of active length. He states further that the odd figure of 0.66 was selected because 0.66 mg. of radium element used for one hour is equivalent to 5 microcuries destroyed. Some of the needles used by Paterson³⁰ contain as little as 0.3 mg. per centimeter of active length and he finds such weak loading useful in holding down the dose in the center of a large implantation. Cade insists that the radium be evenly distributed throughout the hollow portion of the needle but others have recently suggested that the concentration be greatest at each end. Such a loading would tend to make the linear dosage uniform rather than highest in the center as it is with standard needles. Other drawbacks of the standard needles are the eyes and points which provide no radioactivity and sometimes render accurate implantations difficult. Myers²⁹ has suggested

the use of wires made of cobalt⁶⁰ which can be made radioactive from one end to the other except for a thin nickel cover designed to eliminate the soft beta rays. The chief objection to such applicators is the short half life of 5.3 years of cobalt⁶⁰ which would make dosage calculations rather complicated.

All are agreed that the needles should be constructed of gold or platinum-iridium and that a wall thickness of 0.5 mm. of platinum-iridium is sufficient to provide proper filtration. However, most of the needles used in England have wall thicknesses varying from 0.6 to 0.8 mm. which provide added strength rather than necessary filtration. Paterson recommends hollow sheaths made to receive short unit cells having wall thicknesses of 0.2 mm. but the larger external diameters of such needles make implantations somewhat awkward in certain locations.

In an effort to simplify implantation techniques I use low intensity needles of only three sizes (Fig. 1). They have over-all lengths of 11.0, 27.0 and 51.0 mm.; they contain 0.66, 1.33 and 2.4 mg. of radium sulphate, and have active lengths of 0.5, 1.5 and 4.0 cm., respectively. The smallest container is a substitute for a radon seed and may be looked upon as a point source. The other two have loadings of 0.88 and 0.66 mg. per centimeter of active length. This arrangement has proved quite satisfactory in practice and falls in line with Paterson's observation that 0.33 mg. per centimeter is rather light and 1.0 mg. per centimeter is rather strong. The smallest container has an over-all diameter of 1.5 mm. with a wall thickness of 0.5 mm. and the others each have an over-all diameter of 1.75 mm. and a wall thickness of 0.6 mm. Some are made with dull trocar points which can hardly be forced through the tough wall of an artery, while others are provided with sharp points more suitable for insertion into hard tumor tissue.

RADON SEEDS VS. RADIUM NEEDLES

After Failla¹¹ described filtered radon implants in 1926 they were almost universally

adopted for interstitial therapy in this country and Martin and Sharp²⁸ published an article in 1931 extolling their points of superiority over radium needles. Although my own experience with low intensity needles was still quite limited, they seemed such a satisfactory substitute for radon seeds that I felt impelled to publish an article¹⁷ comparing the two types of interstitial therapy in 1932. A conviction that the quantity of radiation needed to pro-

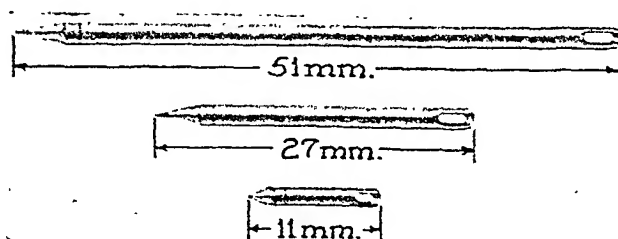


FIG. 1. Scale drawing of the three radium needles used by the author. They contain 2.4, 1.33 and 0.66 mg. of radium, respectively.

duce a given biological effect was less with the needles than with radon was soon dissipated by Failla but the other advantages claimed at that time still hold good. Chief among them is the more even distribution obtainable with the longer radium implants. As a rule, a preconceived pattern can be set up in the tissues so that it delivers a given dose. If roentgenograms show an uneven distribution, the positions of the needles can be readily readjusted. Even when seeds are implanted with great care the distribution patterns are often quite poor and unless removable seeds are used rearrangement is impossible. Most of the radon implants available in this country have a wall thickness of 0.3 mm. With this type of filtration almost 9.0 per cent of the transmitted radiation consists of beta rays. Although Failla believes that this relatively small quantity of the more destructive type of radiation can do little harm, it is my opinion that it increases the number of undesirable reactions, particularly when used in the mouth or near the mucosa of the bowel.

Low intensity needles are always stitched in place and attached to a guy thread so that they can be recovered even when the

stitches pull loose. Some tumors melt down rather rapidly and seeds may slip out of position and be lost. This disadvantage assumes real importance in intra-oral work because the small foreign bodies can be aspirated and they have on several occasions produced lung abscesses. When they remain in their proper positions they become multiple foreign bodies retained in the healed scar, a condition which does not seem entirely desirable in itself.

On purely theoretical grounds it has been claimed that the rapidly diminishing intensity of the radioactivity produced by radon does not produce the same effect on a malignant cell as the steady output of radium. If it be true that a given intensity should be maintained until a certain number of mitoses have taken place this contention may be worthy of consideration but clinical results do not seem to support it.

On the other side of the picture it should be pointed out that seeds may be placed in locations which are inaccessible for needle implantations, and it is also true that the patient may go home immediately after they are placed in position thereby avoiding the stay in the hospital required for needle therapy. However, for many patients with cancer a short stay in a good hospital may prove quite advantageous in that helpful measures consisting of the treatment of anemia, correction of nutritional deficiencies and proper hygiene can be instituted. The physician can also be certain that the radioactive sources are retained in their proper positions during the entire course of treatment. Some have contended that the larger needles produce much more discomfort than seeds but post-implantation discomfort has been mild in my experience even when large areas are covered.

DOSAGE

The estimation of tissue doses produced by interstitial implants is not simple and it has proved so baffling to some radiologists that they have limited their therapeutic activities to roentgen therapy possibly because less skill and time are required and most of the work can be delegated to

technicians. Fortunately, everyone does not accept the pessimistic attitude of Ackerman and del Regato¹ who state that an accurate dosimetry is not possible with the use of radium.

In 1934 Paterson and Parker³¹ published data which placed low intensity radium needle therapy on a sound basis. They stressed the importance of the time factor and observed that with an exposure time of eight days a dose of 6,000 gamma roentgens delivered to the whole of a tumor and the tumor-bearing zone produced permanent resolution of the majority of the epitheliomata so treated. They also observed that most areas in the mouth would tolerate doses of 12,000 gamma roentgens without the formation of permanent necroses. The mucosa of the vagina was found to have a similar tolerance but the maximum safe dose for the rectal mucosa was given as 10,000 gamma roentgens. Smaller doses were advised for larger volumes of tissue in which the total amount given should not exceed 7,000 gamma roentgens. These figures established the limits between which all dosage should be set in practical work and patterns were described for areas of different sizes and shapes designed to deliver a fairly uniform dose of approximately 6,000 gamma roentgens to all malignant tissue in a given region. In 1938 the same authors³² published curves from which the number of milligram hours needed to produce 1,000 gamma roentgens under stated conditions could be obtained for both planar and volume implants.

Although these curves were very valuable they left much to be desired. In 1944 Quimby³⁹ published tables which were of great practical value because they provided data from which doses could be estimated at any point in a tumor implanted with needles regardless of the pattern or types of needles employed. However, even when these data were made available it was necessary to lay out the implantation patterns on paper in two dimensions if accurate calculations were to be carried out and such a procedure was too involved for practical use.

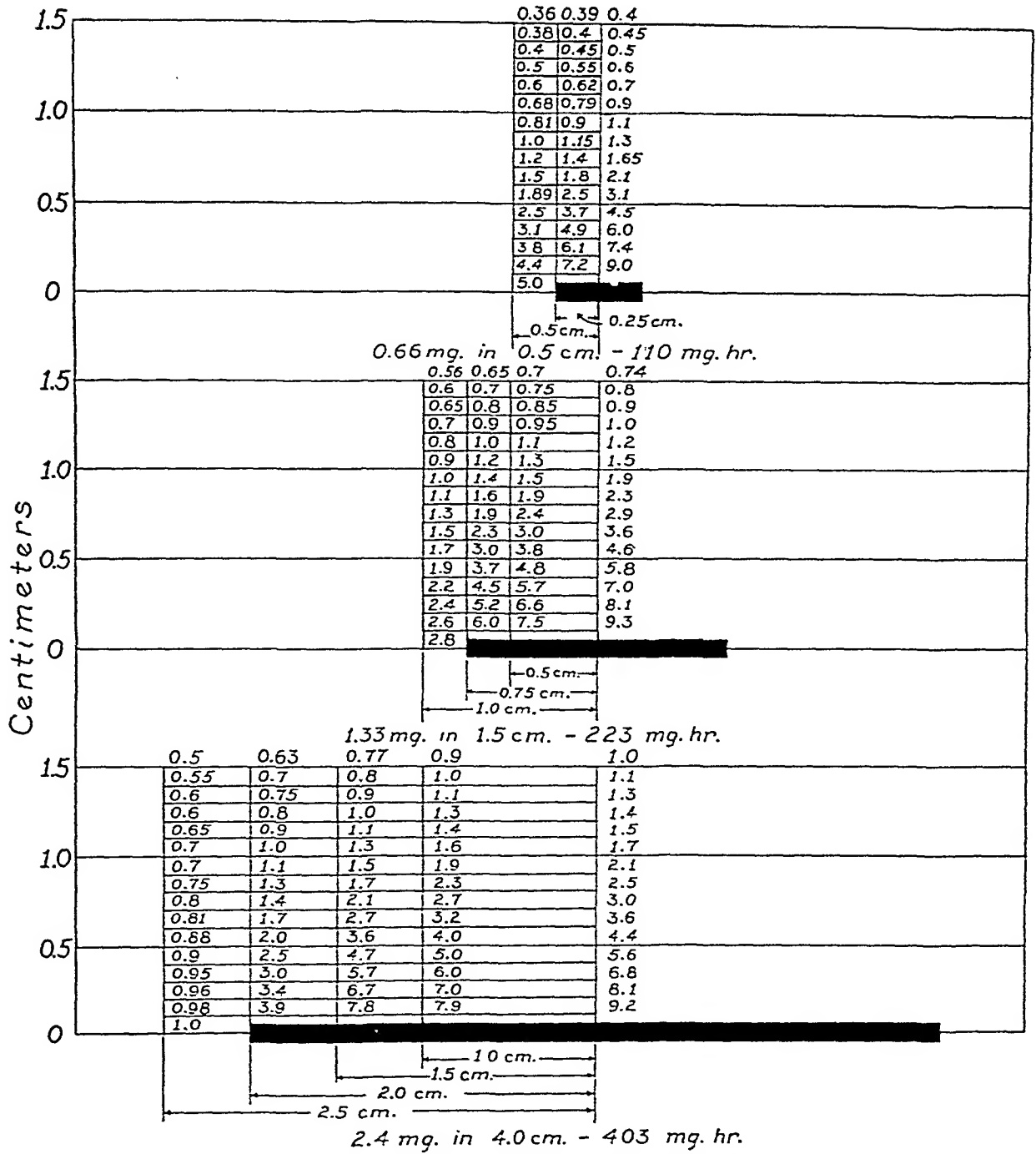


FIG. 2. Dosages delivered in seven days about the active lengths of the three needles illustrated in Figure 1. The figures must be multiplied by 1,000 to convert them into gamma roentgens.

In our Clinic the problem was simplified by fixing the time of all implantations at seven days. It was then possible with the aid of Quimby's tables to prepare a chart depicting the doses in gamma roentgens delivered at multiple designated points about the active lengths of the three needles described above (Fig. 2). From these data the total dose delivered to any point in a tumor by all of the needles implanted could be easily calculated after the pattern had

been laid out in two dimensions. Studies were first made on layers of tissue having a thickness of 0.5 cm. and it was soon found that the three needles adopted could be placed in standard patterns and spaced 1.0 cm. apart so that all of the cells in the layer would receive doses ranging between 6,000 and 12,000 gamma roentgens. It is obvious then that in practice one of these standard patterns can be used thereby eliminating all calculations. With large tumors having

unusual shapes two or more patterns must be combined and at times this procedure poses a difficult problem, but therein lies the art of medicine which no amount of mathematical calculation can completely eliminate. None can deny that the uniform dosage advocated by Paterson and Parker would be preferable to this plan but its

wet field and no more comfortable suture material has been found for intra-oral work. After a long thread is passed through the eye of each needle it is knotted well to one side of its center so as to leave a long and a short portion free. The threaded needles, together with all of the sharp edged instruments to be used, are then submerged

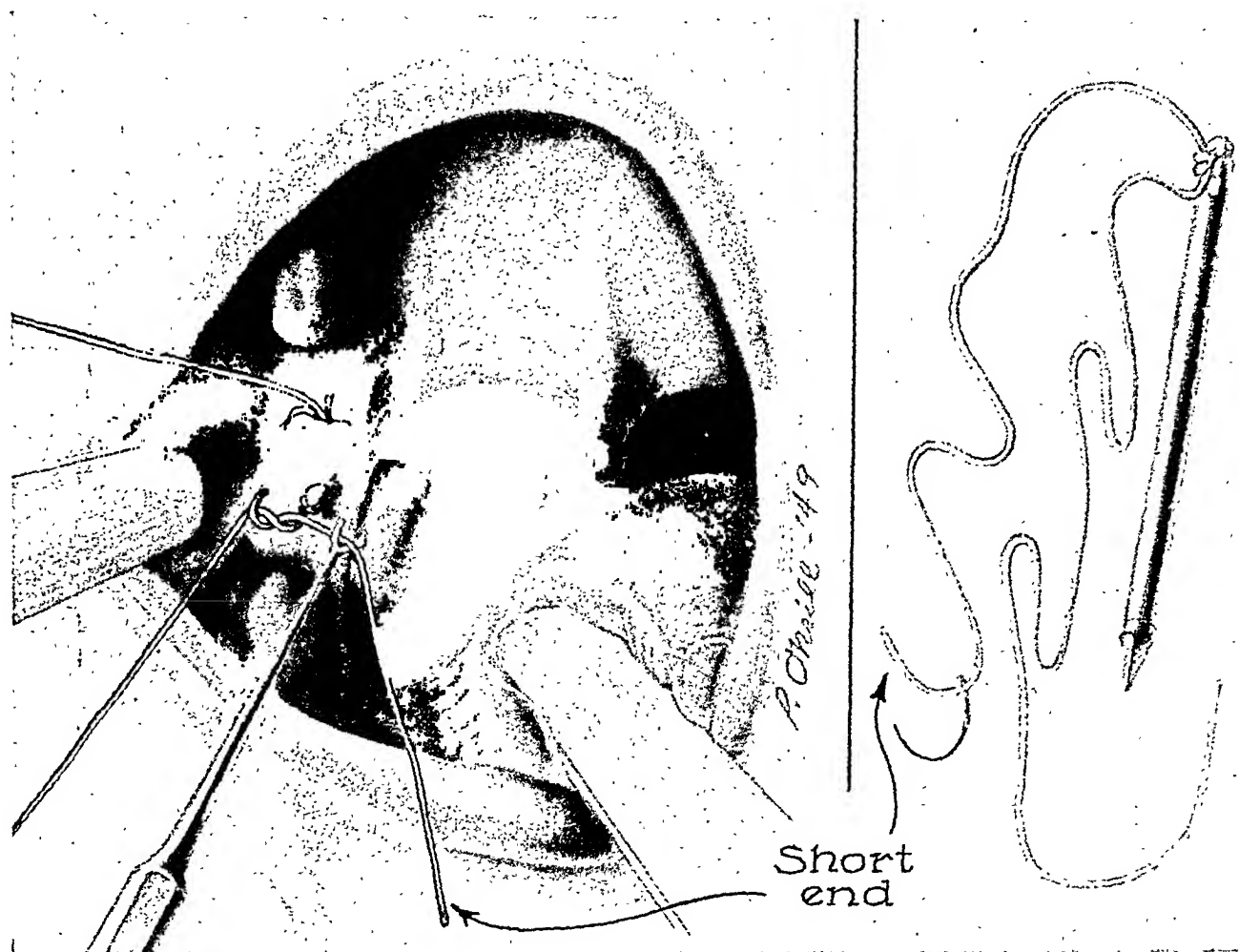


FIG. 3. Method used in stitching radium needles in the base of a tumor of the tonsil. The instrument with a Y-shaped tip may be used to tie knots in inaccessible locations without placing the fingers in the mouth.

ease of application and the good results obtained seem to commend it.

TECHNIQUE

After a tumor has been measured and the approximate pattern decided upon, the correct number of radium needles of each size is placed on the loading bench and threaded with strong dental floss. This thread which is waxed and is supplied in sealed, sterile containers each holding 150 yards makes excellent suture material. The waxed strands do not become tangled in a

in a zephirin solution (1:1,000) for a period of five minutes. All other instruments are sterilized by boiling in a standard sterilizer. The radium needles are laid out on a table with a sterile cover placed well away from the operator and the instruments are placed on another sterile table situated near the operative field.

External skin surfaces to be implanted are scrubbed with green soap, painted with merthiolate and draped with sterile towels except near the eye, where 5 per cent mercurochrome is substituted for merthio-

late. For intra-oral work the mouth is first sprayed with 2 per cent pontocaine after which the face is washed with soap and the mucous surfaces are painted with iodine before the drapes are put in place. For pelvic work the vagina is thoroughly scrubbed with green soap and painted with iodine.

Pelvic lesions are treated after the intravenous administration of sodium pentothal but in other locations local anesthesia is rapidly induced with 0.75 per cent butyn sulphate drawn from a 100 cc. bottle fitted with a permanent rubber diaphragm stopper which has been sterilized with alcohol. Contamination of the anesthetic remaining in the bottle is prevented by using an 18 gauge needle for withdrawal of the solution through the rubber diaphragm. This needle is always replaced by smaller gauge needles for the actual injections and it is never inserted into the tissues. The butyn which contains epinephrine is sterile when it comes from the manufacturer. It may be kept indefinitely, is always ready for immediate use and is quite economical because only the necessary amount need be withdrawn for the case at hand. Reactions are not encountered if the total amount of the anesthetic used does not exceed 20 cc. and if the patient receives an average dose of one of the barbiturates about two hours before the implantation is started. It is also customary to administer $\frac{1}{6}$ grain of morphine about one hour before the patient comes to the operating room. For intra-oral work the mouth must be rendered dry by giving $\frac{1}{100}$ grain of atropine along with the morphine.

A specimen for study is next removed with biopsy forceps and all bleeding is controlled with electrocoagulation. Every effort is then made to reduce the malignant tissue to be implanted to a single layer prior to implantation. This may be done by removing all projecting portions of a fungating tumor by electrocoagulation or by removing portions of the ear or nose with the endotherm knife. With some solid tumors where this cannot be accomplished radium needles are inserted immediately in a pattern designed to adequately irradiate

the entire neoplasm. For implantations through intact skin, small incisions are made with a sharp scalpel at each needle site. All needles are countersunk beneath the surface with a long narrow rod having a depression in one end. After the implantation is completed each needle is stitched in place. This is accomplished with

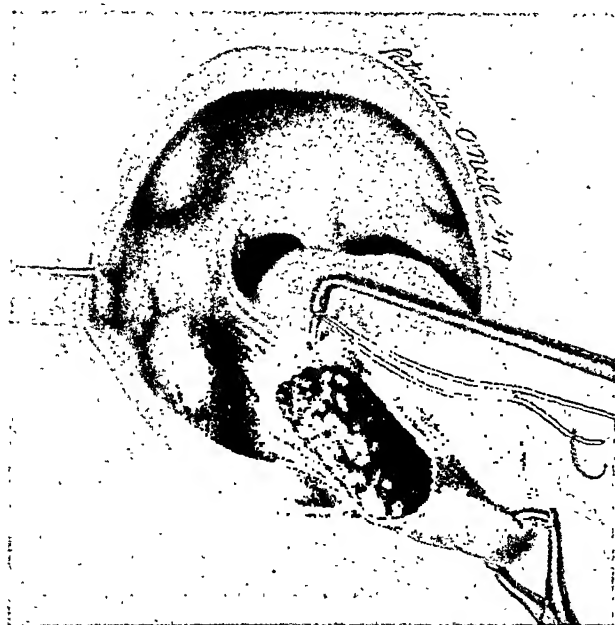


FIG. 4. Method used in inserting needles behind a lesion on the lateral border of the tongue.

a curved needle threaded with the short suture attached to the eye of the radium needle. It is best to insert the sewing needle through the puncture wound and always to sew directly away from the lesion. The two threads are then knotted directly over the head of the radium needle and the excess portion of the short thread is cut away. The longer threads are finally tied together as guy threads and attached to an identification tag which is firmly fixed in some convenient location with adhesive tape.

All patients remain in the hospital for seven days. External implanted areas are cleansed daily and dressed with boric acid ointment. With intra-oral lesions a mouth wash is used after each meal and the treated area is painted with 5 per cent mercurochrome. Needles inserted into the cervix, vaginal walls or parametria are not sutured but are held in place by gauze packs soaked

in a mixture of balsam peru in castor oil (a dram to the ounce). These packs are changed every other day.

At the end of 168 hours all needles are removed, usually without an anesthetic. When each suture is cut on the side of the knot away from the needle, removal by means of tension applied to the guy thread should not be too difficult. In some instances it is necessary to remove a deep-seated needle by grasping the outer end with a small hemostat inserted into the original puncture wound. Occasionally a needle buried in the parametrium must be guided through a puncture wound in the vaginal wall by the tip of a finger, but for the most part all of the work is done with instruments without bringing the fingers near the radioactive sources. On the few occasions when needles have been lost well below the surface, removal has been accomplished under roentgenoscopic control. Radiologists with war experience are well trained for this procedure. Patients who have had pelvic implantations are directed to use mild douches twice daily for a period of six weeks after leaving the hospital. All others continue the type of general care used in the hospital until the puncture wounds have healed and the irradiation reactions have subsided.

COMPLICATIONS

Under ideal conditions the radium reaction reaches its peak in about three weeks and has subsided in six weeks. Healing requires periods varying from six weeks to several months, depending upon the size of the area treated. With the technique recommended by the author some portions of the implanted region receive larger doses than others. For this reason they may heal slowly and in some instances small patches of necrosis may require special care. In wounds on skin surfaces such reactions often respond well to alvangel or to an ointment containing vitamins A and D. Persistent sloughs are removed by electrocoagulation or other surgical procedures. Deep-seated infected ulcers may be cleaned up rapidly with gauze packs soaked in a

penicillin solution (100,000 units in 3 ounces of normal saline solution).

In the mouth daily applications of Scott's solution are very useful in clearing up small areas showing necrosis. It is usually made up to contain 2 gm. of gentian violet, 55 cc. of 95 per cent alcohol, 10 cc. of acetone and 35 cc. of distilled water. It is important that this substance be applied accurately to the involved region and not spread over the oral mucosa. When teeth are removed and infection is carefully controlled before implantation, bone necrosis is reduced to a minimum by the use of low intensity radium needles. However, in certain instances, particularly in the more advanced cases, some bone damage cannot be avoided. Daland⁷ has recently published an excellent review of the proper care of this complication. Small segments of devitalized bone will often separate of themselves under expectant care continued for several months. In some instances healing is accelerated by removing exposed bone with electrocoagulation or with rongeurs. Extensive necrosis in the mandible should be treated by complete surgical excision. Surprisingly good function is preserved even when half of the mandible is resected.

HAZARDS

Everyone engaged in radiation therapy should give some thought to protecting himself against the hazards of his profession. Far too many have developed severe anemias and leukemias and the hands of most of the pioneers active in the development of radon seed techniques show serious damage. Departments of roentgenology are now provided with protective devices which should insure the health of those who work in them, and workers using radioactive materials should receive equal protection. It is my opinion that low intensity radium element needles can be used so as to produce the least hazard of any of the radioactive sources available for therapy. The permanent heavy filter and the small amount of radium in each container reduces the intensity of radiation to which the operator is

exposed during the short time needed for an implantation to a very low figure. Since all manipulations are done with instruments and since the amount of radiation delivered at a distance of 2.0 cm. from the center of a low intensity needle in a few hours is almost negligible, the reasons for this statement are obvious. When the tips of the fingers are used to tie sutures or to facilitate the removal of a deep-seated container they are only brought near the ends of the needles which give off very little radiation. Perhaps the condition of the author's own hands provide the best evidence in favor of his contention. After a period of eighteen years during which many hundreds of low intensity needle implantations have been done no skin damage can be made out. The nails are somewhat brittle and show slight longitudinal ribbing but are otherwise normal. It might be added that some of these changes may have resulted from radiation received from other sources used in an active general radiological practice carried on during the past thirty years.

CANCER OF THE FACE, NECK AND EAR

In the southwestern portion of the United States the treatment of cancer of the exposed cutaneous surfaces constitutes one of the major problems encountered in a tumor clinic. Phillips²⁴ states that 33.8 per cent of 3,683 cancers recorded in the United States Public Health survey made for the Dallas-Fort Worth area in Texas in 1939 were cutaneous lesions. In my opinion, such tumors appearing on the dorsal surfaces of the hands respond best to electrocoagulation or excision, but most carcinomas of the face and neck may be eradicated with radiation therapy. The techniques used are described in a recent article.²⁵ The smaller lesions measuring 2 cm. or less in diameter receive low voltage roentgen therapy but the larger ones, particularly those showing extension into the deeper tissues, are treated with 200 kv. roentgen rays using a divided dose technique, or with low intensity radium needles.

Fortunately neoplasms on the forehead, temples and cheek tend to grow in planes so that they are well suited for layer needle implantations, and when fungoid masses are encountered they can easily be removed by electrosurgery thereby converting the residual malignant tissue into flat masses. Large flat malignant ulcers often seen in the external cheek just in front of the ear tend to extend downwards into the parotid region and radical surgery almost invariably damages branches of the seventh cranial nerve and produces facial paralysis. These lesions respond quite well to low intensity radium needle implantations which never produce nerve injury. Primary cancer arising in the parotid gland may be treated in the same manner, with good cosmetic results.

Dermatologists tend to stress the importance of using smaller doses for basal than for squamous cell carcinomas. It has been our experience that large basal cell tumors are often quite radioresistant and for that reason the dosage used is the same regardless of the histopathological type revealed by biopsy studies. This so-called resistance to irradiation may be due to the fact that a careful search will often reveal cells of both types in the larger tumors. Some pathologists report squamous cell carcinomas as radiosensitive or radioresistant on the basis of Broders' classification. Since all of these tumors do equally well with the radium dosage recommended in this paper, such a classification is confusing to the uninitiated. In fact, the largest number of permanent cures is obtained with Grade I lesions because they tend to metastasize much later than the more radiosensitive types.

Many radiologists seem to share the opinion of Ackerman and del Regato who state that "interstitial curietherapy is an expeditious method of treatment which is only justified in small lesions." I would agree that an accurate implantation of radon seeds into large areas might prove quite difficult but the results illustrated in Figures 5 and 6 should convince the most



FIG. 5. Cancers of face. *Upper.* Mixed squamous and basal cell carcinoma, well four years and nine months after needle therapy without facial nerve damage. *Middle.* Large squamous cell carcinoma, well seven years after needle therapy showing no facial nerve damage. *Lower.* Deep-seated basal cell carcinoma, well four years and nine months after needle therapy. Although there is some scarring present the mouth can be fully opened.

skeptical that planar needle implants have a definite place in the treatment of massive deep-seated carcinomas of the face.

Many large cancers of the face and neck arise in or about the ear and the poor

it is our custom to remove the damaged cartilage with electrosurgery before instituting any form of radiation therapy. Although some good results have been obtained with divided dose roentgen therapy



FIG. 6. Cancers of the face. *Upper.* Large basal cell carcinomas of the forehead complicating von Recklinghausen's disease, well three years and nine months after radium needle therapy. The deformity of the left eye resulted from the unsuccessful use of a cancer paste applied elsewhere. *Lower.* Squamous cell carcinoma, Grade I, with radiation slough in center, well one year after excision of the slough and radium needle therapy.

results obtained with such lesions in general practice are described in a recent article²² in which the observation is made that 72 per cent of the cases entering our Clinic had been treated unsuccessfully elsewhere. When the auricle shows extensive invasion

we have come to depend more and more on radium needles for eradication of the residual malignant tissue in and about the auditory canal.

Patients who have been over-irradiated elsewhere and present themselves for treat-

TABLE I

ADVANCED CUTANEOUS CANCER OF THE FACE AND
NECK TREATED WITH RADIUM NEEDLES

	Well 3 or More Years		Well 5 or More Years	
	Total Num- ber	Well	Toal Num- ber	Well
Face	55	25—45.4%	38	12—31.5%
Neck	20	8—40.0%	17	5—30.0%
Ear	53	23—43.4%	41	15—36.5%

ment with active carcinoma growing about a painful area of necrosis pose one of our most difficult problems. When possible, all devitalized tissue is removed with sharp

scissors or by electrocoagulation before the needles are inserted under the active portions of the neoplasm. It is particularly important that all cartilage showing irradiation necrosis be removed as a preliminary procedure.

The results obtained with radium needles are tabulated in Table I. In evaluating the relatively low five year salvage of 30 to 36 per cent it must be remembered that only the worst cases were treated with radium needle therapy and that most of the patients were quite old. In other words, many of them died in less than five years from distant metastases or other causes and many were untraced. The importance of this observation is emphasized by the fact that the primary lesions healed satisfactorily in 60 per cent of the entire series.

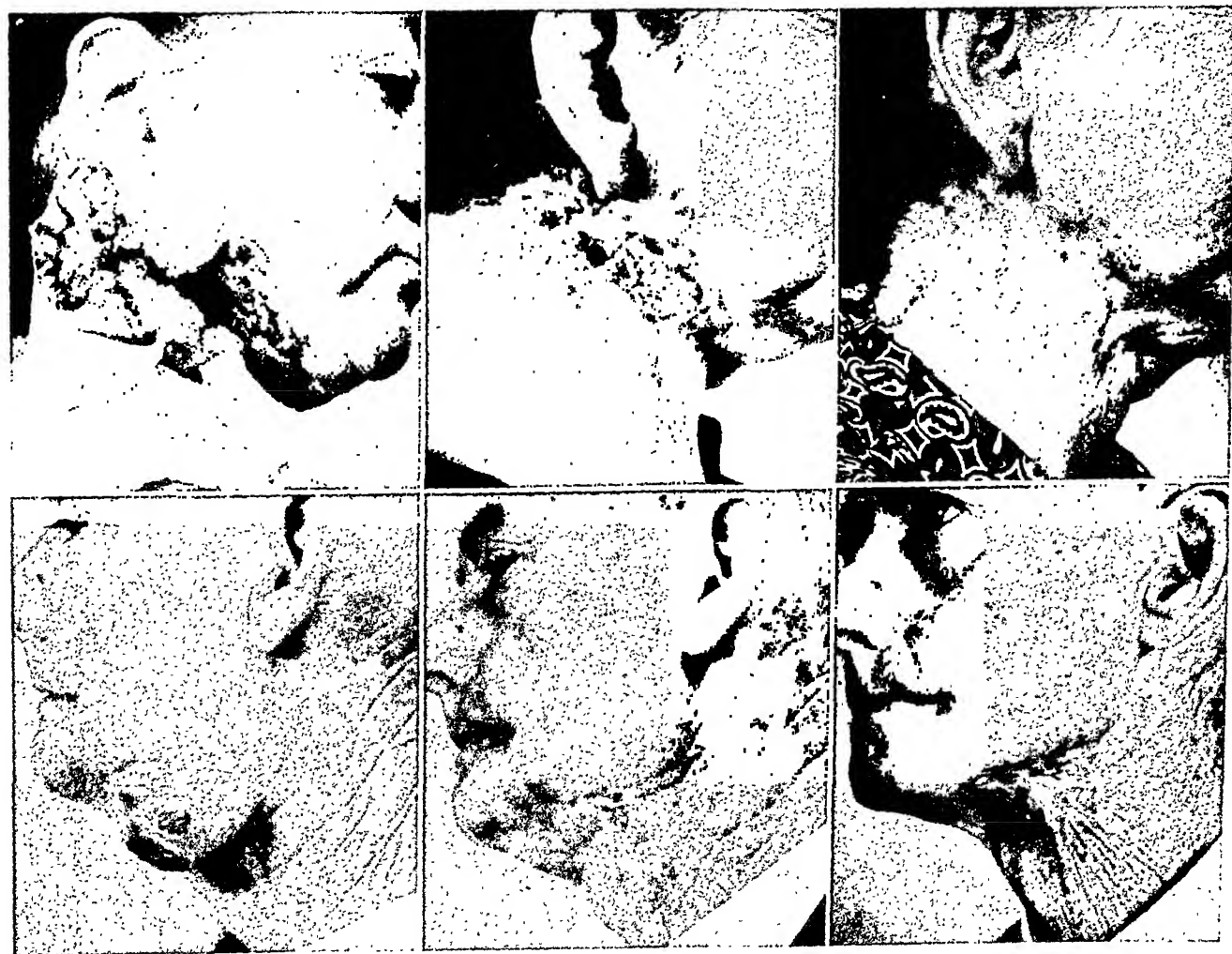


FIG. 7. Cancers of skin of neck. *Upper.* Large tricho-epithelioma of the skin, well one year after radium needle therapy and excision of the slough shown in the central photograph. *Lower.* Fungating squamous cell carcinoma, Grade 1, well two years after electrocoagulation followed by radium needle therapy.

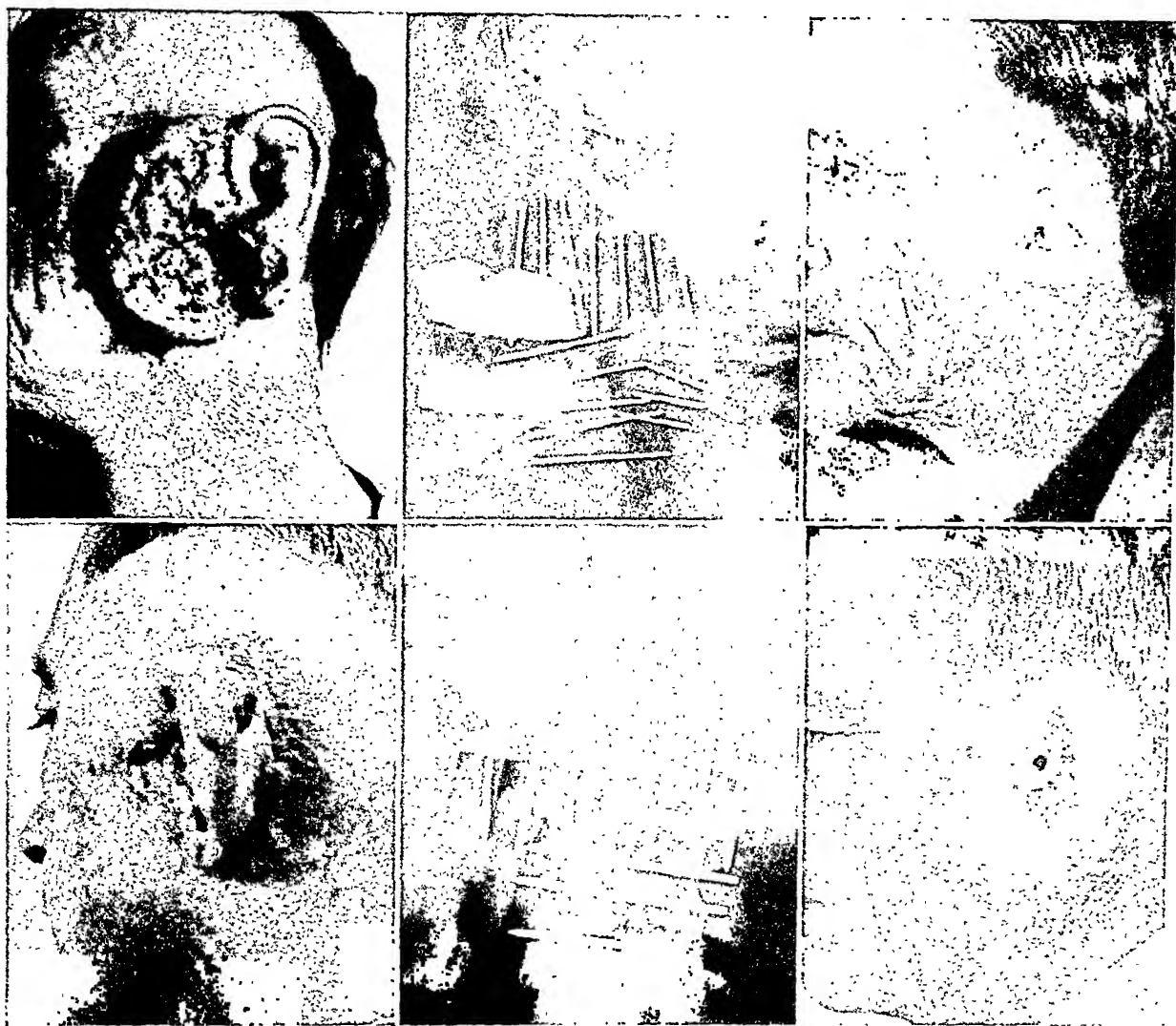


FIG. 8. Cancers of the ear. *Upper.* Large squamous cell carcinoma completely undermining the ear, well four and a half years after removal of the pinna by electrosurgery and radium needle therapy. *Lower.* Squamous cell carcinoma, Grade I, undermining the ear, well one year and ten months after removal of the pinna by electrosurgery and radium needle therapy.

CANCER OF THE CANTHI

The importance of cancer of the eyelids and canthi is emphasized by Driver and Cole⁹ who observed 324 such lesions (16.8 per cent) in a series of 1,925 patients with epithelioma of the skin. Small carcinomas of the eyelids are treated with low voltage roentgen rays given with eye shields of the type described by Hunt,¹³ but large lesions involving either canthus respond best to radium needle therapy. This is particularly true when the disease has extended well down into the orbit or has involved the bridge of the nose and the cheek. Satisfactory patterns can usually be worked out with the small 0.66 mg. radium needles

which are often planted directly into tumors of the lids and I do not hesitate to insert a row of 1.33 mg. needles vertically into the outer portions of the orbit when deep extensions are present. It is also worthy of note that superficial lesions growing on the nose without cartilage involvement respond well to the same type of therapy (Fig. 9). In a series of 27 large tumors treated from 1937 to 1948 good primary healing was obtained in 24 (88.8 per cent). Of this group 73 per cent had been treated unsuccessfully elsewhere with caustics, surgery or some type of irradiation. The failures occurred in those patients having deep extension through the underlying bony structures. Of 15 patients

treated five or more years ago, 11 (or 73.3 per cent) have remained well. The commonest complication encountered in the inner canthus is an obstruction of the tear ducts from fibrosis during the healing stage. A good ophthalmologist can often keep these ducts open by careful dilatations started about one month after treatment. A slight

eyes when they are first seen. In 3 of our cases this condition became noticeably worse in the years immediately following therapy but the others reported no changes in their vision. Even when the needles were inserted well down into the orbit no muscle damage was observed in any of our patients. On the whole, it may be stated that the com-



FIG. 9. Basal cell carcinoma of the inner canthus, both eyelids, the right side of the nose and the upper lip, well two years after removal of the ala of the nose and radium needle therapy.

conjunctivitis may follow irradiation and in 6 of our cases it persisted but caused very little discomfort. The danger of cataract formation secondary to irradiation has been discussed at some length by Hunt. Many of the patients with cancer of the inner canthus are in the old age group and have some clouding in the lenses of both

plications were not serious and the cosmetic results were superior to those resulting from radical surgery with enucleation of the eye.

CANCER OF THE LIP

Most tumor clinics now recommend radical surgery for all but the earliest malignant lesions of the lips but I believe that

TABLE II
ADVANCED CANCER OF THE LIP TREATED WITH RADIUM NEEDLES

	Well 3 or More Years		Well 5 or More Years	
	Treated 1933-1946	Well	Treated 1933-1944	Well
All cases	88	36-40%	77	26-33.7%
Without nodes	37	18-48.6%	32	15-46.8%
With nodes	51	18-35.2%	45	11-24.4%

irradiation followed by surgical procedures in some instances, produces the best cosmetic results obtainable. Such tumors measuring less than 2.0 cm. in diameter are treated with low voltage roentgen rays

tumor tissue left after the removal of the projecting portions by electrosurgery is particularly well suited for this procedure. The restoration of the lower lip is often so satisfactory that no plastic procedures are



FIG. 10. Large cancers of the lip. *Upper.* Squamous cell carcinoma, Grade 2, well twelve years after radium needle therapy. *Middle.* Squamous cell carcinoma, Grade 1, well six years after electrosurgery and radium needle therapy. *Lower.* Squamous cell carcinoma Grade 1, well one year after radium needle therapy showing a restoration of the vermilion border without plastic surgery.

unless they are accompanied by deep infiltration, but most of the larger ones, regardless of their size, can be eradicated with a carefully worked out planar implantation of radium needles. Since the lip is a relatively thin structure the residual layer of

indicated. However, when cancer has infiltrated the entire lip and invaded the mucous surface, destruction of the neoplasm must of necessity destroy much of the lip and a plastic repair should follow irradiation to prevent the leakage of saliva.

Those who may feel inclined to criticize the low five year salvage of 33.7 per cent set down in Table II should take note of the fact that our material was very unfavorable. More than half of these patients had palpable cervical nodes at the time

not cured by irradiation. In my opinion, these recurrences resulted from improper needle patterns and they should be eliminated as more experience is gained. The treatment of the metastatic nodes which was carried out with irradiation alone will

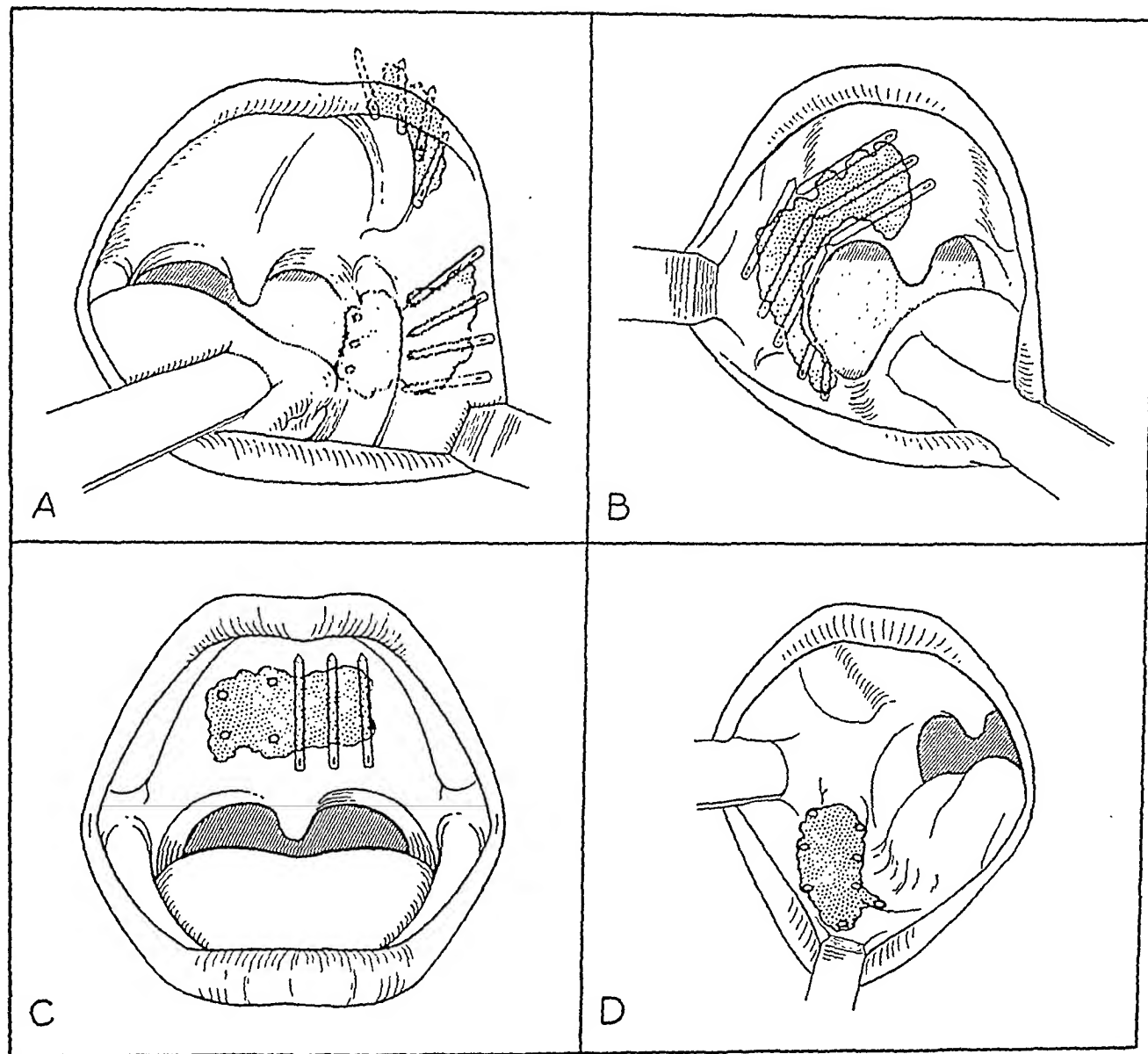


FIG. 11. Radium needle patterns used for cancers of the internal cheek, alveolar process and palate.

they were treated, and 25 were admitted for the treatment of the nodes after the primary lesion had been cured elsewhere. Many cases could not be traced for five years but a partial follow-up of 63 patients with large primary lip carcinomas showed that satisfactory healing was produced by radium alone in 51, or 80 per cent. In the remaining 20 per cent it was necessary to coagulate or excise small areas which were

be discussed in another portion of this paper.

INTRA-ORAL CANCER

Intra-oral cancers, especially the larger, more complex tumors, present difficult surgical problems and even the more radical operators depend to some extent on irradiation. In this country most lesions in the mouth are treated with intra-oral cone

therapy, external roentgen therapy, intra-oral radium contact devices or implanted radon seeds. These techniques have been described by Richards,^{42,43} Pfahler,³³ Cutler,⁶ Martin and Sharp,²⁵ Martin and Pflueger,²⁷ and others. Even Cade and Paterson, who are enthusiastic about low intensity radium needles, limit their use to

Here again some preliminary electrosurgery is often necessary and it is desirable that teeth in the field of treatment, particularly those about which infection is observed, be removed before radium is inserted. Adequate treatment of irregular tumors may require some ingenuity when they are extensive enough to involve more

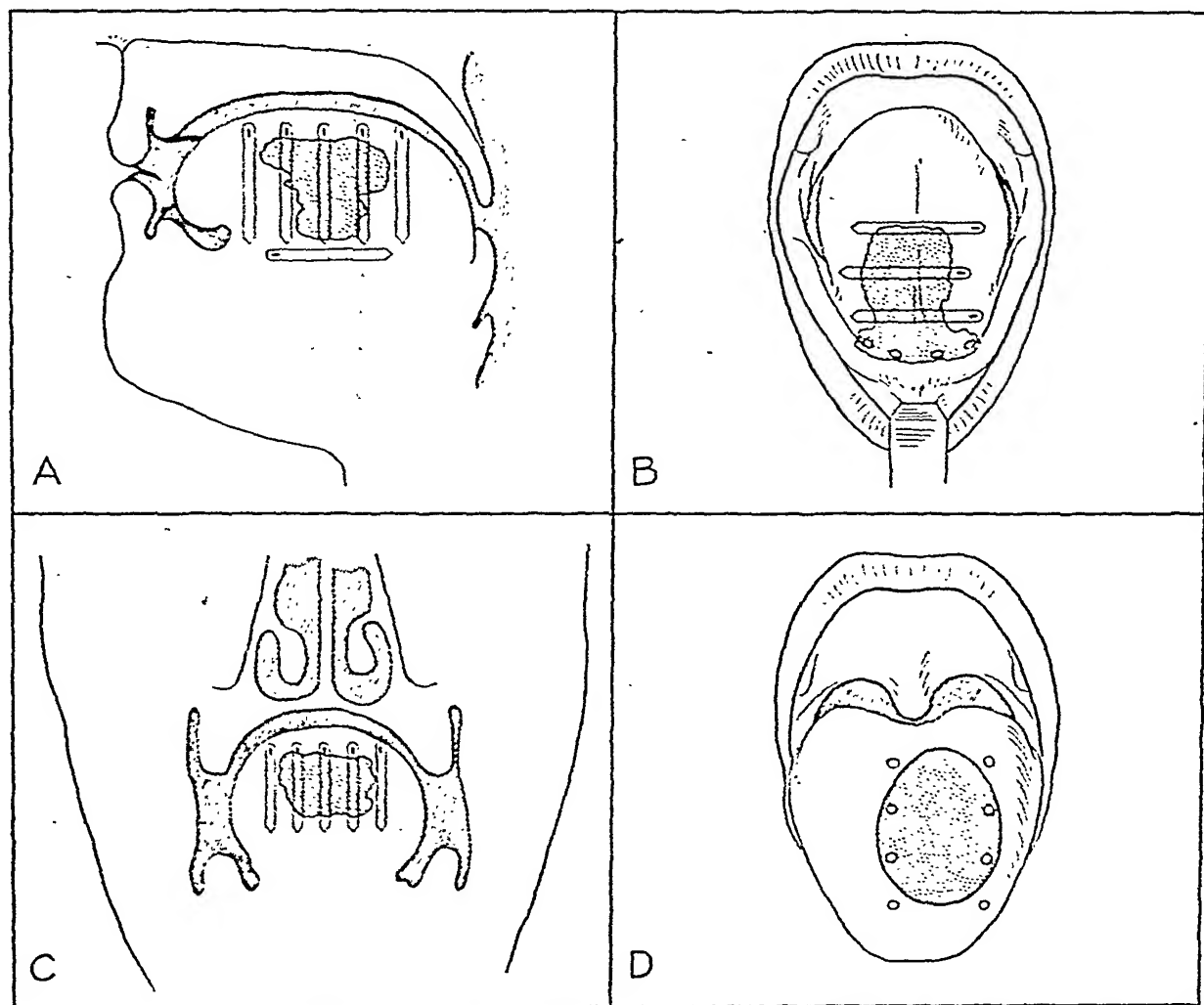


FIG. 12. Needle patterns used for cancer of the tongue. *A*—lateral border, *B*—under side with involvement of floor of mouth and alveolus, *C*—base of the tongue, and *D*—large central tumor.

intra-oral lesions not in contact with bony structures. In an effort at simplification of equipment I have used such needles in all lesions in the mouth with the full knowledge that many authorities think this procedure is ill advised.

With the exception of bulky tumors located within the tongue, almost all cancers in the mouth can be converted into planes or combinations of planes for implantation.

than one portion of the mouth. Some of the basic patterns are illustrated in Figures 11 and 12 but each case is a problem in itself and the operator must try to visualize the positions assumed by the needles after the mouth is closed. Postoperative roentgenograms often indicate that several readjustments are necessary. Some of the needles may become displaced after a few days, and in certain difficult cases reimplantations

TABLE III
INTRA-ORAL CANCER TREATED WITH RADIUM NEEDLES

	Well 3 or More Years		Well 5 or More Years	
	No. treated 1930-1946	Well	No. treated 1930-1944	Well
Cheek	98	43-43.8%	76	34-44.7%
Tongue	68	23-33.8%	52	12-23.0%
Alveolus	21	12-57.1%	19	11-57.8%
Floor of mouth	14	8-57.1%	11	5-45.4%
Soft palate	8	3-37.5%	6	2-33.3%
Hard palate	9	4-44.4%	7	3-45.4%
	218	93-47.2%	171	68-40.0%

have been done as many as three times during the seven days of treatment. Good results have been obtained in many such cases and it has occurred to me that the

shifting of the radioactive sources may be desirable since it changes the locations of the "hot spots" in the tumors.

The results obtained in 218 consecutive cases treated completely with radium needles are given in Table III. The term "completely" is used advisedly because the metastatic nodes observed in more than one-third of these patients (Table IV) were also treated with radium needles plus roentgen therapy. Although the five year salvage amounted to only 40 per cent in this entire group, complete healing of the primary lesion was obtained in 63.7 per cent, as shown in Table V. Some have expressed the belief that cures can be expected with interstitial irradiation only when the intra-

TABLE IV
INCIDENCE OF METASTATIC CERVICAL LYMPH
NODES IN INTRA-ORAL CANCER

	Total Number of Cases	Cases with Nodes at First Visit	Cases with Nodes Observed Later
Cheek	98	24	5
Tongue	68	25	15
Alveolus	21	3	2
Floor of mouth	14	2	3
Soft palate	8	3	0
Hard palate	9	0	0
	218	57	25

TABLE V
INTRA-ORAL CANCER TREATED WITH
RADIUM NEEDLES

Region	Number of Cases	Primary Lesion Healed
Cheek	98	61-62.2%
Tongue	68	38-55.8%
Alveolus	21	17-80.3%
Floor of mouth	14	10-80.3%
Soft palate	8	7-87.5%
Hard palate	9	6-66.6%
	218	139-63.7%

TABLE VI
NINETY-THREE CASES WITH INTRA-ORAL CANCER
WELL THREE OR MORE YEARS

	Largest Diameter of Primary Lesion		
	Less than 2.0 cm.	2.0 cm. to 3.0 cm.	3.0 cm. or or more
	Cases	Cases	Cases
Cheek	11	13	19
Tongue	4	6	6
Alveolus	2	5	5
Floor of mouth	4	2	2
Soft palate	1	1	1
Hard palate	1	0	3
	23	34	36

oral tumors are of small size and that a good salvage rate is obtained only when most of the lesions treated are small. Table VI was prepared to show that more than two-thirds of the 93 tumors which remained well for three or more years measured 2.0 cm. or more in diameter and more than one-third of the group measured 3.0 cm. or more in diameter.

Space does not permit a discussion of the

to general belief, the close apposition of the small heavily filtered sources to bone did not invariably produce devitalization and bone necrosis although superficial layers of bone did slough away before healing occurred in a few cases. A similar experience with cancer of the hard palate indicates that low intensity needles can be used near bone with a minimum amount of damage. As a rule, no attempt is made to irradiate

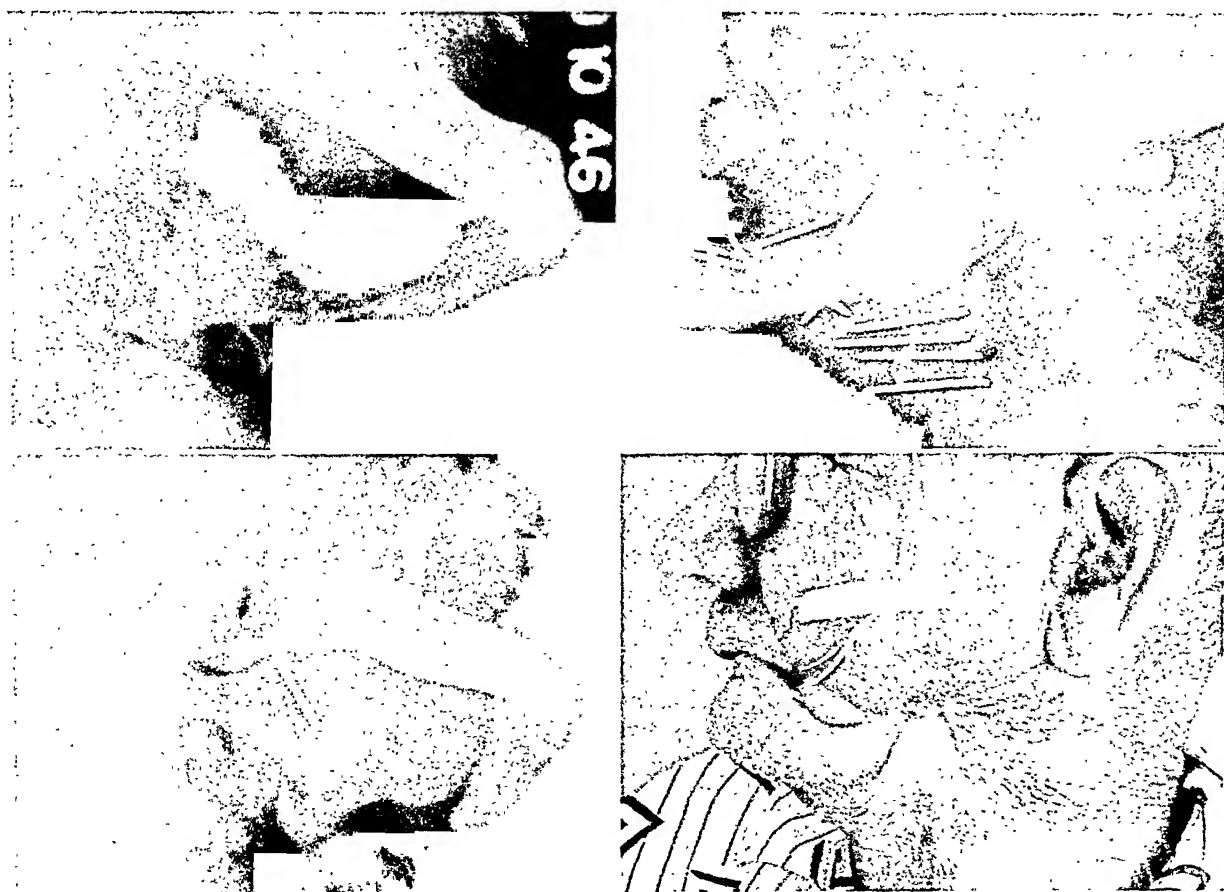


FIG. 13. Large squamous cell carcinoma, Grade 2, of lower left alveolus with bone invasion, well two and a half years after radium needle therapy followed by sloughing of the central portion of the mandible. The lower photographs were made during treatment of a new lesion on the soft palate.

technical details which enter into the proper implantation of each portion of the mouth. However, some comment seems indicated on the high rate of healing (80.3 per cent) obtained with carcinomas involving the tissues overlying the alveolar processes. Most lesions of this sort were treated with small 0.66 mg. needles inserted vertically in two rows, one on the inner and the other on the outer side of the alveolus. Contrary

lesions which have actually invaded bone but the series of events illustrated in Figure 13 show the complete eradication of one such lesion. This case suggests that a successful technique might be evolved for the care of local bone invasion.

METASTATIC CERVICAL LYMPH NODES

The complete care of patients with cancer of the head and neck must include the treat-

ment of metastatic cervical nodes. Although most surgeons feel that block dissection offers the only chance of cure, the operation has not yielded a high five year cure rate even in selected early cases. Many radiologists have advocated various types of external irradiation but this method has produced no lasting results in our hands except in a few cases secondary to transitional cell carcinoma of the pharynx. In 1931 Quick³⁶ advocated the use of radon implants in individual nodes as an effective procedure to be used after the external administration of roentgen radiation to the cervical region. He adopted the combined method because Quimby and Pack⁴⁰ had shown that larger doses could be used with safety in this manner than with either roentgen rays or radium alone. It was his belief that cervical lymph nodes perform a conservative function and hence should not be disturbed, particularly in the presence of an active primary growth. Later in 1931 Martin and Sharp²⁸ described a further experience with this technique and stated: "After several years' experience with block dissection of the neck we believe that implantation with gold seeds offers equally good end results in operable cases without the operative risk of the major surgical procedure." In 1935 Quick³⁷ again published a review of his method and said that it was indicated in all cases except the Grade 4 group unless the case fell in the limited group for surgical dissection or was extremely advanced. In 1940 Martin, Munster and Sugarbaker²⁶ described this technique in detail. External roentgen radiation is given through small circular ports (3 to 5 cm. in diameter) applied to each separate node and, depending on the size of the port, 4,000 to 8,000 r is given in daily divided doses over a period of two to three weeks. Immediately on the completion of this external dose, radon seeds in a tissue dose of 5 to 10 skin erythema doses are implanted either through puncture wounds in the skin or after surgical exposure of the outer surface of the node.

The work of Quick, Martin and their collaborators indicated that the large doses

needed to control metastatic epidermoid carcinoma in cervical nodes could rarely be given safely except with a combination of external and interstitial radiation. The weakness in their technique seemed to lie in the small areas covered and in the poor distribution of radon seeds shown in roentgenograms of implanted regions. It occurred to me that a better distribution of the irradiation over large areas could be obtained with low intensity radium needles which, because they emit only gamma rays, should provide an even higher factor of safety. Since it is not desirable to implant needles through skin which has been heavily irradiated it seemed best to start the roentgen therapy after the needles were in place. In most locations it was found possible to set up a planar implantation extending along the lymphatic bed well beyond the involved nodes. Heavily filtered daily doses of 350 r were then given over the needled region with 220 kv. roentgen rays until a total of 2,100 r had been given. The details of this technique are included in previous articles.^{18,19,20} The roentgen-ray dosage was less than that used by Quick and Hayes Martin because it was given simultaneously with the radium therapy. The first case receiving this plan of therapy was treated in 1935. The patient had two large submental glands secondary to a carcinoma of the lip. An excellent result was obtained and the patient is still well after fourteen years of observation.

In 1937 we adopted the policy of treating all metastatic cervical lymph nodes in patients with proved primary epidermoid carcinoma of the face, neck and mouth with this new technique. Since that date, 287 cases have received this type of therapy and 146 were treated prior to March, 1944 (Table VII). No block dissections were done for any of these patients. Of this group 40, or 27.3 per cent, have remained well for five or more years; 91 are known to be dead; and 15 are untraced. Most of the cases were followed for at least a few months, and our most interesting observation was the fact that in 102, or 70 per cent, of the



FIG. 14. Metastatic cervical lymph nodes. *Upper.* Metastatic cervical nodes shown to contain squamous cell carcinoma by excision of a node, well six years after combined radium needle and roentgen therapy. *Middle.* Fixed hard nodes containing cheesy material appearing after cure of a squamous cell carcinoma of the lower lip, well seven and a half years after combined radium needle and roentgen therapy. *Lower.* Squamous cell carcinoma in large node of undetermined origin proved by needle biopsy, well six years after combined radium needle and roentgen therapy.

TABLE VII
ALL PATIENTS WITH METASTATIC CERVICAL NODES TREATED
WITH IRRADIATION 1937-1944

Primary Lesion	Number of Cases	Living and Well—Years							Well Five or More Years
		11	10	9	8	7	6	5	
Lip	50		2	4	1	1		6	14
Internal cheek	26		1				2	3	6
Tongue	27			1			1	2	4
Face and neck	20		1				2	3	6
Floor of mouth	3	1				1			2
Ear	4		1					1	2
Alveolus	4							1	1
Undetermined	6					1	3		4
Soft palate	3							1	1
Tonsil and pharynx	3								0
	146	1	5	5	1	3	8	17	40—27.3%

146 cases the palpable glands disappeared. Since many of these cases were far advanced we feel that this is a creditable result. Certainly it compares very favorably with the five year cure rate of 26 per cent reported by Hayes Martin²⁵ for a group of 65 selected cases treated by block dissection.

In old age groups five year statistics do not always reflect the true worth of a method. This is borne out in a study of the cause of death in the 91 cases that did not survive for five years. Only 46 of these patients died of the cancer treated. The causes of the fatal outcome listed for the other 45 are tabulated in Table VIII. Since many of these cases had obtained complete

remissions of the primary lesions and the cervical nodes some might have survived for five years except for the intercurrent disease.

Our work has been criticized repeatedly because no biopsy studies were made on the enlarged nodes in most of the cases reported. It is our contention that those of us who have worked with cancer of the head and neck for many years make few mistakes in the clinical diagnosis of well developed metastatic lymph nodes appearing in patients with proved primary lesions. In many of our cases the nodes became palpable after the primary cancers had healed. Rapid extensions seen in necks from which single nodes had been removed surgically have made us hesitant to advise such a procedure for diagnostic purposes. Needle biopsy is a safer method which has been adopted during the past few years.

As an answer to certain surgeons who have stated that no metastatic cervical lymph nodes proved to contain squamous cell carcinoma have ever been cured with irradiation alone Table IX was prepared. In this group of 17 cases treated five or more years ago some of the diagnoses were made by needle biopsies and others by the removal of single nodes. It is now possible for us to state that 9 proved cases have been

TABLE VIII
METASTATIC LYMPH NODE CASES TREATED FIVE OR MORE YEARS AGO KNOWN TO BE DEAD

Total number of cases	91
Dead of cancer treated	46
Dead of other causes	45

Unknown cause	9	Cancer of larynx	1
Heart disease	2	Cancer of colon	1
Cerebral hemorrhage	3	Metastases:	
Nephritis	2	pulmonary	10
Pneumonia	4	liver	1
Cirrhosis of liver	1	bone	4
Cancer of prostate	1	brain	4

TABLE IX

METASTATIC HISTOPATHOLOGICALLY PROVED SQUAMOUS CELL CARCINOMA
IN CERVICAL LYMPH NODES TREATED BY IRRADIATION

Primary Lesion	Number of Cases	Living and Well—Years					Well Five or More Years
		10	9	7	6	5	
Lip	11		1	1		2	4
Face	2	1					1
Undetermined	4			1	3		4
	17	1	1	2	3	2	9

cured by our technique alone. Although most of the nodes were relatively small in these patients, one had a mass in the neck measuring 6.5 by 4.0 cm.; another had a cervical node measuring 3.5 cm. in diameter, and a third had multiple nodes in both submental and the left cervical region. These 9 cases together with the 46 reported by Hayes Martin²⁵ in 1941 offer positive proof that metastatic cervical lymph nodes containing proved squamous cell carcinoma

can be cured by a combination of interstitial radioactive sources and roentgen therapy.

Many seem to share the opinion of Donlan⁸ who states that "the fibrosis and scarring produced by interstitial radium needles causes excruciating pain in the neck." With the technique advocated in this paper no such complication has been observed. When large sections of the neck are treated the overlying skin does even-

TABLE X

ADVANCED CANCER OF CERVIX

Lesions	Other Treatment	Radium	Roentgen Rays	Results
4 cm. cervical stump; left parametrium	Subtotal hysterectomy 20 years ago	Weak needles, cervix—left parametrium	2 × 1,200 r, left with radium	Well 10 years
Entire cervix; left parametrium; vaginal wall	Left nephrectomy at 9 months	Weak needles, all lesions	2 × 1,260 r, left with radium	Well 6½ years
Cervical stump: left parametrium	Subtotal hysterectomy years ago	Weak needles, both lesions		Well 5 years and 7 months
Large cervix; both parametria	Subtotal hysterectomy 3 months ago	Weak needles—1,200 mg.-hr.; capsules in cervical canal		Well 5 years
Cervical stump; vaginal walls	Subtotal hysterectomy 7 years ago	Weak needles—1,050 mg.-hr.; capsules in cervical canal		Well 3 years
Cervical stump; both parametria	Subtotal hysterectomy 7 months ago	Weak needles, all lesions		Well 3 years
Entire cervix; both parametria		Weak needles—4,200 mg.-hr.; capsules in cervical canal	4 × 1,200 r, 2, 7 and 12 mo. after radium	Well 2 years

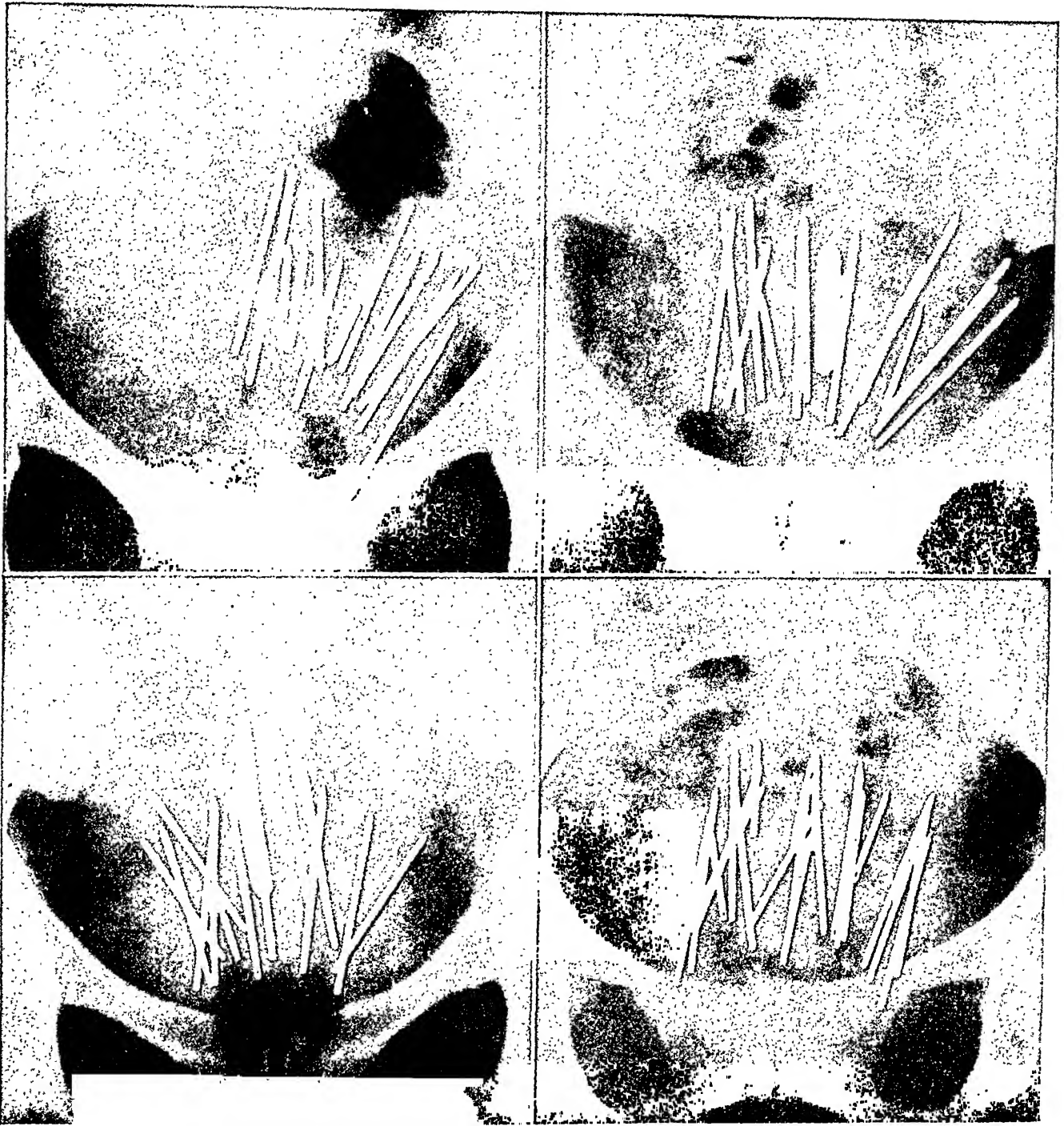


FIG. 15. Radium needle patterns used in 4 cases of carcinoma of the cervix with parametrial extension all of which showed marked improvement with no troublesome sequelae.

tually show some atrophy and a freckled appearance and telangiectases may eventually appear in the scar, particularly in the lower cervical region. It is also true that some subcutaneous fibrosis appears in the larger areas. This complication produces some stiffness and may be accompanied by the same mild discomfort with sudden changes in the weather observed with other large scars. In a few cases small superficial ulcers have appeared in the skin five or six years after treatment, usually

following trauma. They have been easily controlled by surgical removal. None of these reactions have produced severe pain and they may be looked upon as relatively unimportant in patients cured of metastatic cervical lymph nodes.

CANCER OF THE FEMALE PELVIS

The value of low intensity radium needles, particularly the longer ones, in the treatment of cancer of the uterine cervix has been emphasized by Pitts and Waterman,³⁵

who began using them routinely in 1926 and reported an absolute five year survival rate of 32.6 per cent of a series of 135 cases treated prior to 1933. Their technique was patterned after that of Barris and Donaldson² who were especially interested in the use of needles to extend efficient irradiation into the parametrial regions. In a recent article Corscaden, Gusberg and Donlan⁵ have shown that as much as 10,000 gamma roentgens may safely be delivered to the outer portions of the parametrium with long needles implanted into this region through the vagina and a diagram published by the author²¹ has confirmed these calculations. Pitts and Waterman usually augment their needle implantations by a long intracervical capsule containing 20 mg. of radium and ~~all of the radium~~ containers are left in place for seven days. They also use rather large additional doses of roentgen rays in some cases but I believe this practice to be hazardous. In our own Clinic our longer needles are used in all cases with parametrial involvement and the addition of moderate doses of roentgen rays has proved advantageous. Cervical stump cases are also treated in this manner and the technique has been most useful in treating the residual masses left by ~~poorly trained~~ surgeons who now ~~too often~~ attempt to operate on inoperable lesions. The number of these patients has ~~un~~fortunately shown a decided increase since so many articles advocating a revival of the Wertheim operation have appeared in the literature.

A few of our encouraging results are shown in Table x. In 1926 Martin and Rogers²³ demonstrated the serious damage which could be produced by high intensity steel radium needles planted in close proximity to the ureters. However, some of our clinical results indicate that low intensity needles placed in the parametria not only do not damage the ureters but may actually restore their normal function by melting down malignant masses which are producing obstruction. Since primary carcinomas of the vaginal wall and secondary implants in these regions tend to grow in layers they

can be efficiently treated with these needles which do not produce irreparable injury to the mucosa of either the rectum or the bladder.

MALIGNANT TUMORS IN OTHER LOCATIONS

Many other accessible malignant tumors are suitable for treatment with low intensity radium needles but only the lesions most frequently encountered have been discussed in this paper. Those who are interested should consult the early work of Keynes¹⁴ on cancer of the breast and Gordon-Watson¹² on cancer of the rectum as well as the more recent books by Cade and by Paterson. Lenz, Cahill and Melicow¹⁶ have published an excellent review of a series of cases of cancer of the bladder implanted after cystostomy. Our own files contain records of patients successfully treated for cancer of the bladder, prostate, breast, anus, urethra and vulva. Suffice it to say that I believe that low intensity radium needles constitute an economical, highly efficient addition to the armamentarium of the radiotherapist who strives for a cure and wishes to obtain the best possible results with the minimum of danger to both himself and his patients.

3501 Gaston Ave.
Dallas, Texas

REFERENCES

1. ACKERMAN, L. V., and DEL REGATO, J. A. Cancer: Diagnosis, Treatment, and Prognosis. C. V. Mosby Co., St. Louis, 1947.
2. BARRIS, J. D., and DONALDSON, M. Radiological work in gynaecological department, St. Bartholomew's Hospital. *Acta radiol.*, 1929, 10, 379-392.
3. CADE, S. Radium Treatment of Cancer. William Wood & Co., New York, 1929.
4. CADE, S. Malignant Disease. Williams and Wilkins, Baltimore, Md., 1948.
5. CORSCADEN, J. A., GUSBERG, S. B., and DONLAN, CHARLOTTE P. Precision dosage in interstitial irradiation of cancer of the cervix uteri. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 522-534.
6. CUTLER, M. Concentration method of radiotherapy for cancer of mouth, pharynx and larynx. *J.A.M.A.*, 1941, 117, 1607-1610.

7. DALAND, E. M. Radiation necrosis of the jaw. *Radiology*, 1949, 52, 205-215.
8. DONLAN, CHARLOTTE P. Irradiation in cancer of the tongue. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 511-521.
9. DRIVER, J. R., and COLE, H. N. Epithelioma of the eyelids and canthi. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 616-624.
10. EVANS, A., and CADE, S. Cancer of tongue; preliminary report on radium treatment. *Brit. J. Surg.*, 1927, 15, 55-70.
11. FAILLA, G. Development of filtered radon implants. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 16, 507-525.
12. GORDON-WATSON, C. Radiation in cancer of the rectum. *Proc. Roy. Soc. Med.*, 1927, 21, 9.
13. HUNT, H. B. Cancer of eyelid treated by radiation; with consideration of irradiation cataract. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 57, 160-180.
14. KEYNES, G. Radium treatment of primary carcinoma of breast. *Lancet*, 1928, 2, 108-111.
15. LENZ, M. Curie therapy of epidermoid carcinoma of intraoral group as carried out at the Radium Institute, Paris. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 15, 210-216.
16. LENZ, M., CAHILL, G. F., MELICOW, M. M., and DONLAN, C. P. Treatment of cancer of the bladder by radium needles. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 58, 486-492.
17. MARTIN, C. L. Small radium needles versus radon implants. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 240-248.
18. MARTIN, C. L. Treatment of metastatic cervical lymph nodes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 819-833.
19. MARTIN, C. L. Treatment of metastatic cervical lymph nodes with irradiation. *Tr. Sect. Laryng., Otol. & Rhinol., A.M.A.*, 1940, pp. 86-108.
20. MARTIN, C. L. Treatment of metastatic cervical lymph nodes; new method. *Texas State J. Med.*, 1941, 37, 236-241.
21. MARTIN, C. L. New developments in irradiation therapy of cancer of the uterine cervix. *Texas State J. Med.*, 1948, 44, 587.
22. MARTIN, C. L., and MARTIN, J. A. Treatment of advanced cancer involving the ear. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 750-757.
23. MARTIN, C. L., and ROGERS, F. T. Effect of irradiation on the ureter. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1926, 16, 215-218.
24. MARTIN, C. L., and WRIGHT, C. Treatment of cancer of the face, mouth and neck with irradiation. *J.A.M.A.*, 1947, 134, 861-867.
25. MARTIN, H. E. Treatment of cervical metastatic cancer. *Ann. Surg.*, 1941, 114, 972-985.
26. MARTIN, H. E., MUNSTER, H., and SUGARBAKER, E. D. Cancer of the tongue. *Arch. Surg.*, 1940, 41, 888-936.
27. MARTIN, H. E., and PFLUEGER, O. H. Cancer of cheek (buccal mucosa). *Arch. Surg.*, 1935, 30, 731-747.
28. MARTIN, H. E., and SHARP, G. S. Use of gold filtered radon implants in treatment of intra-oral cancer. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 26, 28-46.
29. MYERS, W. G. Applications of artificially radioactive isotopes in therapy. I. Cobalt⁶⁰. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 816-823.
30. PATERSON, R. The Treatment of Malignant Disease by Radium and X-Rays. Williams and Wilkins Co., Baltimore, Md., 1948.
31. PATERSON, R., and PARKER, H. M. A dosage system for gamma ray therapy. *Brit. J. Radiol.*, 1934, 7, 592-632.
32. PATERSON, R., and PARKER, H. M. A dosage system for interstitial radium therapy. *Brit. J. Radiol.*, 1938, 11, 252-266.
33. PFAHLER, G. E. Treatment of cancer of the lip and mouth. *Radiology*, 1940, 35, 598-605.
34. PHILLIPS, C. Relationship between skin cancer and occupation in Texas. *Texas State J. Med.*, 1941, 36, 613-616.
35. PITTS, H. C., and WATERMAN, G. W. A further report on the radium treatment of carcinoma of the cervix uteri. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 567-576.
36. QUICK, D. Interstitial radiation in metastatic cervical nodes of epidermoid carcinoma. *Ann. Surg.*, 1931, 93, 380-390.
37. QUICK, D. Radium in the treatment of metastatic epidermoid carcinoma of cervical lymph nodes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1935, 33, 677-681.
38. QUICK, D. Therapeutic radiology. *Radiology*, 1948, 50, 283.
39. QUIMBY, E. H. Dosage table for linear radium sources. *Radiology*, 1944, 43, 572-577.
40. QUIMBY, E. H., and PACK, G. T. Skin erythema for combinations of gamma and roentgen rays. *Radiology*, 1929, 13, 306-312.
41. REGAUD, C. Some biological aspects of radiation therapy of cancer. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 12, 97-101.
42. RICHARDS, G. E. Radiological treatment of cancer, 1929-1935; carcinoma of the tongue. *Canad. M.A.J.*, 1936, 35, 593-598.
43. RICHARDS, G. E. Radiological treatment of cancer, 1929-1935; intra-oral lesions (except tongue). *Canad. M.A.J.*, 1936, 35, 599-603.
44. ZOWERS, Z. T. The uses of radium. Correspondence between Z. T. Zowers and Alexander Graham Bell. *Am. Med.*, 1903, 6, 261.

TRACHEO-ESOPHAGEAL CONSTRICTION PRODUCED BY RIGHT AORTIC ARCH AND LEFT LIGAMENTUM ARTERIOSUM*

By EDWARD B. D. NEUHAUSER, M.D.

BOSTON, MASSACHUSETTS

IN 1946 two papers^{2,3} from The Children's Hospital of Boston presented a working classification of anomalies of the great vessels at the base of the heart. In these and more recent papers little attention has been devoted to the course or importance of the ductus Botalli. This structure when in association with an aorta which is abnormal in course and position may well produce symptoms.

Partial Classification of Aortic Arch Anomalies

Right aortic arch without visceral inversion.

1. Anterior type—arch is anterior to trachea, descending on the right.
 - a. Associated with right ductus Botalli.
 - b. Associated with left ductus Botalli.
2. Posterior type—arch passes to the left behind the esophagus and descends on the left or just to the right of its normal left sided position.
 - a. This may be associated with a persistent left aortic diverticulum giving origin to the left subclavian and ductus Botalli.
 - b. The left subclavian may arise from the right arch and pass behind the esophagus.
3. Left aortic arch descending on the right (Paul).⁴
 - a. Associated with right ductus Botalli (Edwards).¹
 - b. Associated with left ductus Botalli.

Recently we have had the opportunity to observe 5 patients with symptoms of constriction of both the trachea and esophagus produced by a vascular ring consisting of a right aortic arch and right descending aorta and a ligamentum arteriosum passing from the pulmonary artery to the left of the trachea and esophagus and then behind the esophagus to join the thoracic aorta on the right side just below the level of

the aortic arch. It is probably true, as Edwards¹ has stated, that the ductus arteriosus or ligamentum arteriosum lies on the same side as the upper portion of the descending aorta, and if that is the case in most instances of right aortic arch with the thoracic aorta descending on the right, the ductus Botalli is also on the right and embryologically is a part of the right sixth arch rather than the normal left sixth arch. However, this is evidently not always the case and the important exceptions are those which will produce symptoms.

Previously we have reported^{2,3} the case of a patient with a right aortic arch descending on the left and left aortic diverticulum producing a posterior indentation on the esophagus and into this diverticulum was inserted the ductus Botalli which evidently arose on the left side. The diagnosis was not made during the life of the patient. The 5 patients to be presented here were with one exception subjected to film and roentgenoscopic examination of the chest with barium swallow, instillation of lipiodol into the trachea and angiocardiology. One patient under a mistaken diagnosis of double aortic arch was operated upon without angiocardiology. In the other patients the roentgen diagnosis was confirmed by surgical exploration by Dr. Robert E. Gross.

This complex of anomalies may produce, if sufficiently constrictive, signs and symptoms indistinguishable from those produced by any constricting ring of the trachea and the esophagus, perhaps most typically seen in the double aortic arch. Wheezing and stridor have been a prominent feature, and several have shown repeated episodes of

* From the Department of Roentgenology, The Infants' and The Children's Hospitals and the Department of Radiology, Harvard Medical School, Boston, Massachusetts. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

respiratory infection and pneumonia. All patients showed a considerable degree of dysphagia, particularly those taking solid foods. Head retraction and increase in the severity of the wheezing and stridor were also evident in the patients in the infant age group. In all of the patients the severity of the symptoms warranted surgical exploration for relief of the vascular ring.

uted to the aortic arch itself, but all patients showed on the posterior aspect of the esophagus at or just below the level of the aortic arch an extrinsic filling defect usually appearing about 0.5 to 1.0 cm. in size. No abnormal pulsation at this defect could be seen. At the same level the left side of the esophagus usually showed a very shallow and barely detectable filling

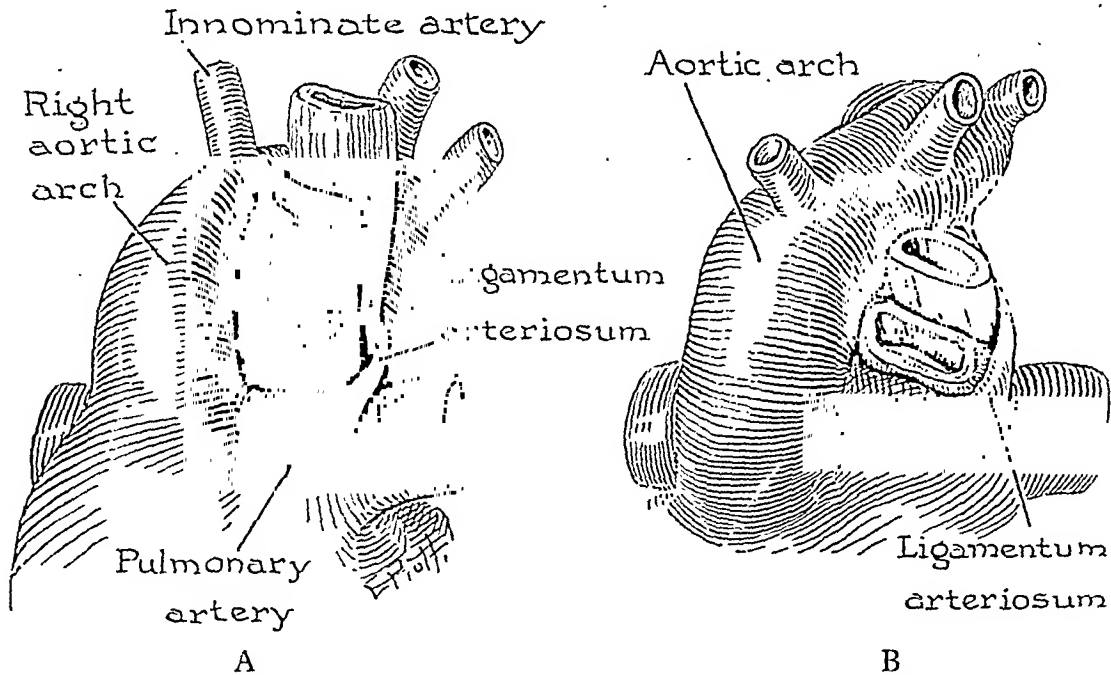


FIG. 1. (A) A drawing made in the left anterior oblique projection shows the relationship of the right aortic arch and the ligamentum arteriosum producing a constricting vascular ring. (B) When viewed from above the constriction of the trachea and esophagus produced by the aorta and ligamentum arteriosum is evident.

The roentgen findings were very similar in all cases and although they resembled strikingly the roentgen changes observed in patients with double aortic arch, close analysis of the findings enables one to make the correct diagnosis, particularly if angiocardiology is done for confirmation. Simple roentgenoscopy without contrast medium showed that the major mass of the aorta and aortic arch was on the right side of the midline. After barium swallow and observation of the course and contour of the barium-filled esophagus, it was evident that the right aortic arch produced a shallow but definite indentation on the right side of the esophagus which could be best seen in the anteroposterior projection and in the left anterior oblique view. In none of the 5 patients could a posterior defect of the esophagus be seen that could be attrib-

defect. After the instillation of the lipiodol into the trachea in the anteroposterior projection a definite rather prominent defect on the right side of the trachea could be visualized in all of these patients. No defect on the left side of the trachea could be seen and no definite narrowing of the trachea in the lateral projection could be identified, although this was suspected in several of the patients.

In 4 of the patients the correct diagnosis of the intrathoracic vascular anomaly was made from these findings, but before surgical exploration was carried out it was deemed wise to inject 70 per cent diodrast to obtain serial films of the heart and great vessels to visualize more clearly the exact anatomical arrangement of the aorta and of its intrathoracic branches. The angiocardigrams exhibited clearly the course of



FIG. 2. Case 1. P. LaC., white male, aged three years, with symptoms of severe stridor and dysphagia dating from shortly after birth, three episodes of pneumonia. In the anteroposterior projection the main mass of the aorta is seen to the right of the midline producing a shallow indentation on the right side of the barium-filled esophagus. A similar but smaller and less marked indentation is seen on the left at the same level.



FIG. 3. Case 1. The posterior defect which appears long and shallow is evidently produced by the ligamentum arteriosum. A small portion of the aortic arch may project posterior to the esophagus.

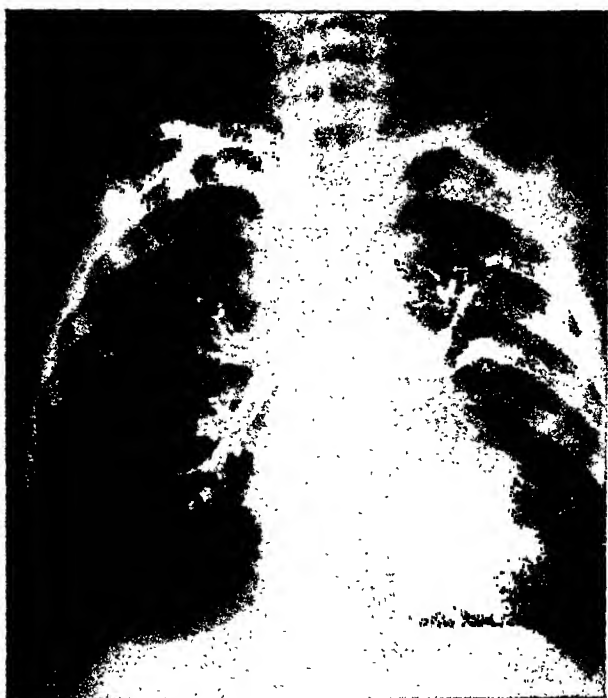


FIG. 4. Case 1. After instillation of lipiodol into the trachea a shallow defect is seen on the right side of the trachea at the level of the aortic arch. The defect is evidently produced by the right-sided aortic arch.



FIG. 5. Case 1. Angiocardiogram depicts the right aortic arch and right descending aorta. The first branch from the aorta is a left innominate. The right common carotid arises as the second vessel and a right subclavian as the third.



FIG. 6. Case II. S. McC., white female, aged ten, who exhibited severe stridor dating from birth and exertional dyspnea; no important dysphagia. In the anteroposterior projection the right aortic arch descending on the right is well seen. This produces a large rounded filling defect on the right side of the barium-filled esophagus. A considerably smaller shallow defect is seen at the same level on the left side.



FIG. 7. Case II. A film made with lipiodol both in the trachea and esophagus shows a shallow posterior defect in the esophagus at the level of the aortic arch and very minimal narrowing of the trachea at the same level.



FIG. 8. Case II. In the anteroposterior projection the prominent defect on the right side of the trachea can be seen. There appears to be a slight deviation of the trachea to the left at this level.



FIG. 9. Case III. R. B., white male infant, severe stridor and dysphagia dating from birth. In this patient the defect on the posterolateral aspect of the barium-filled esophagus appears to be quite large, but at operation it was found to be produced by the ligamentum arteriosum alone. The aortic arch was entirely on the right side and the aorta descended on the right.

the aorta with the arch on the right side and the thoracic aorta descending on the right. In 2 patients in which this procedure was done there was reversal of the aortic arch branches so that the innominate artery arose as the first branch and divided into a left subclavian and left common carotid, while on the right the two vessels emerged from the aortic arch separately. Naturally no visualization of the ductus Botalli was obtained, as in each patient this structure was closed.

Only 1 patient showed a cardiac anomaly that could be recognized. This patient was cyanotic, presented a soft systolic murmur and showed a right axis deviation on the electrocardiogram and was thought to have a tetralogy of Fallot. In addition, the patient had an anomaly of the tracheobronchial tree in that the right upper lobe bronchus arose separately from the trachea about 1 cm. above the bifurcation. This anomaly is of considerable significance in a patient with a right aortic arch as the aortic arch courses above this anomalous bronchus and we have seen several patients in whom this anomaly produced alternating



FIG. 11. Case IV. M. K., white female infant, with stridor and dysphagia dating from birth, shows on barium swallow the mass of the aorta to be on the right and a shallow defect on both the right and left sides of the esophagus at the level of the aortic arch. The defect on the left side is lower in position and is evidently produced by the ligamentum arteriosum.

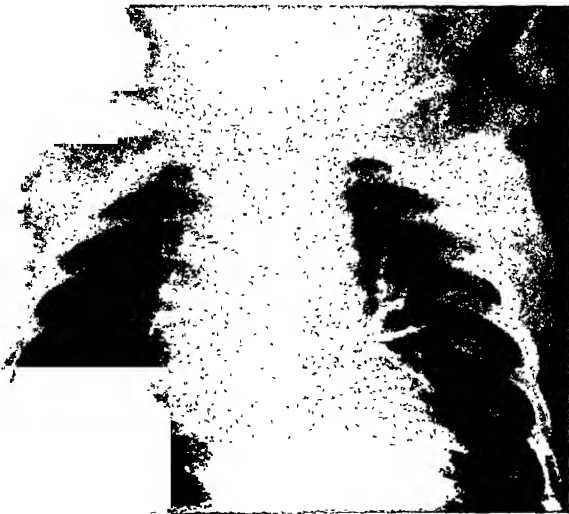


FIG. 10. Case III. After instillation of lipiodol into the trachea an appearance essentially similar to the previous patient is seen—a shallow defect on the right side of the trachea at the level of the aortic arch. The major mass of the aorta is seen on the right. The patient evidently has an engorged azygos vein which can be seen to the right of the spine.

atelectasis and obstructive emphysema of the right upper lobe. However, at the time of examination no evidence of pressure from the aorta on the anomalous right upper lobe bronchus could be detected.

It is probable that the anomaly of a right aortic arch descending on the right with a vascular ring produced by the ductus Botalli is relatively uncommon. Undoubtedly in many patients the vascular ring is not sufficiently severe either to produce symptoms, or, if present, symptoms insufficient to warrant surgical exploration with division of the ligament. Probably other similar or closely related anomalies exist only to await recognition during life. Paul⁴ has reported on patients with a left aortic arch with the thoracic aorta descending on the right side. Edwards¹ has seen at autopsy a patient with right ligamentum arteriosum which evidently produced some constriction.



FIG. 12. Case IV. In the right anterior oblique projection a deep notch in the posterolateral aspect of the esophagus is seen. This defect at operation was found to be due entirely to the ligamentum arteriosum.



FIG. 13. Case V. K. V., white female, aged two, with cyanosis, dyspnea, stridor and dysphagia dating from birth. In the right anterior oblique projection

If the condition is kept in mind the differential diagnosis should not be too difficult if a thorough and complete examination is done, and we do not believe that angiocardiology is necessary to establish the correct roentgen diagnosis. The anomaly most apt to be confused with this picture is that of the double aortic arch, particularly when the posterior or right arch passing behind the esophagus is the smaller of the two. All of the patients with double aortic



FIG. 14. Case V. Following the instillation of lipiodol into the trachea an anomalous right upper lobe bronchus arising from the trachea above the bifurcation is seen. The aortic mass is on the right and there is a shallow defect on the right side of the trachea at the level of the aorta. A diagnosis of tetralogy of Fallot with vascular ring produced by a right aortic arch descending on the right and a ligamentum arteriosum on the left was made. As yet operation has not been carried out on this patient.

a rounded defect is seen on the posterolateral aspect of the esophagus, evidently produced by the ductus Botalli. A shallow defect could be seen on the right side of the esophagus produced by the right aortic arch.

arch that we have seen have produced a defect both on the right and left sides of the esophagus as well as a definite posterior defect. Similar changes have been noted in the trachea after visualization with lipiodol. None of the patients with double aortic arch, and the roentgen diagnosis has now been made in 18, have exhibited the main vascular mass of the aorta on the right side, but rather did it seem equally divided between the right and left side and on plain roentgenoscopy usually was not a particularly evident structure.

Although we have had no recent example of a right aortic arch with left aortic diverticulum retro-esophageal in position with a ligamentum arteriosum entering the diverticulum, it is probable that the picture produced by this anomaly would even more closely resemble the picture produced by a double aortic arch. However, the exact diagnosis is rarely of great importance as with considerable ease the diagnosis of a constricting ring can be made and if symptoms are sufficiently severe surgical exploration carried out with division of some portion of the ring. It seems likely that one occasionally will find a patient with an anomalous course of the aorta with a patent ductus Botalli. Here the roentgen changes could be identical to those described, but in addition the patient should present the characteristic murmur of a patent ductus arteriosus. The recognition of the position of the ductus in these patients would be of considerable importance to guide the surgeon in his operative approach for section or ligation of the ductus.

SUMMARY

Five patients who exhibited severe stridor and dysphagia are discussed. In these patients the symptoms were due to

a right aortic arch with the thoracic aorta descending on the right side and a ligamentum arteriosum arising from the pulmonary artery and passing to the left of the trachea and esophagus and behind the esophagus to the thoracic aorta producing a constrictive ring.

On roentgen examination these patients showed the aortic vascular mass to the right of the midline, an indentation of the barium-filled esophagus seen on the right side of the esophagus in the antero-posterior projection and in the left anterior oblique view, and a small defect on the posterior aspect of the esophagus produced by the ligamentum arteriosum as it passed behind the esophagus from the left side. The trachea showed a shallow extrinsic pressure defect on the right side.

Surgical exploration with division of the ligamentum arteriosum and freeing of the vascular structures was carried out by Dr. Robert E. Gross, evidently with complete relief of stridor and dysphagia. It is believed that these are the first instances of this procedure.

300 Longwood Ave.
Boston 15, Mass.

REFERENCES

1. EDWARDS, J. E. Retro-esophageal segment of the left aortic arch, right ligamentum arteriosum and right descending aorta causing a congenital vascular ring about the trachea and esophagus. *Proc. Staff Meet., Mayo Clin.*, 1948, 23, 108-116.
2. GROSS, R. E., and WARE, P. F. Surgical significance of aortic arch anomalies. *Surg., Gynec. & Obst.*, 1946, 83, 435-448.
3. NEUHAUSER, E. B. D. Roentgen diagnosis of double aortic arch and other anomalies of the great vessels. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 56, 1-12.
4. PAUL, R. N. A new anomaly of the aorta; left aortic arch with right descending aorta. *J. Pediat.*, 1948, 32, 19-29.



THE ROENTGENOGRAPHIC AND ANGIOCARDIOGRAPHIC ASPECTS OF (1) ABERRANT INSERTION OF PULMONARY VEINS ASSOCIATED WITH INTERATRIAL SEPTAL DEFECT AND (2) CONGENITAL ARTERIOVENOUS ANEURYSM OF THE LUNG*

By ARTHUR GRISHMAN, M.D., M. H. POPPEL, M.D., R. S. SIMPSON, CAPTAIN, MC, USN,
and M. L. SUSSMAN, M.D.

NEW YORK, NEW YORK

ABERRANT INSERTION OF PULMONARY VEINS ASSOCIATED WITH INTERATRIAL SEPTAL DEFECT

THE increasing need for precise diagnosis in congenital heart disease necessitates an analysis of even rare anomalies. Aberrant insertion of pulmonic veins has been regarded as an anatomic curiosity. Clinical and roentgenographic descriptions of this condition have not been found.

Only recently, Brody⁴ reviewed in detail the embryology of the pulmonic veins and described the many variations in insertion. Of the cases in which complete drainage of the pulmonic veins into the right side of the heart occurred (mostly into the coronary sinus), only three are known to have survived infancy. With the drainage of only the veins of one lung to the venous side, however, the rate of survival beyond infancy was much higher. In all of the cases in which both pulmonic veins were abnormal, cardiac symptoms occurred, whereas symptoms rarely occur when only one of the pulmonic veins has an aberrant insertion; hence, these cases are found only at postmortem. However, they have invariably been associated with a particular type of slit-like interatrial septal defect located above and posterior to the fossa ovalis.^{2,5,13} In addition, the right atrium and ventricle have usually been found enlarged and hypertrophied, and the pulmonary artery dilated.

White²⁵ states, "Congenital anomalies of the veins are of little or no clinical im-

portance. . . . The diagnosis of uncomplicated congenital defects of the great veins has not yet been made during life." Indeed the defects compatible with life beyond infancy cause no significant disturbance of the hemodynamics. If, however, they appear as a structure in the roentgenogram of the chest, they require identification and precise analysis. This has been made possible by the proper application of angiocardio-graphic recordings through the serial exposure technique.^{18,19,20,21} In this way a study of the anatomy of these structures and of the sequence of passage of the diodrast opacified blood mixture through the various structures is possible.

We have observed and are reporting 3 cases of aberrant insertion of the right lower lobe pulmonic vein. One case, seen in consultation, presented an aberrant insertion of the right upper lobe vein.

In 2 cases, cardiac murmurs were discovered in early childhood, and the third case was discovered incidental to a routine roentgenographic examination of the chest. Case A. R. (Fig. 2, 3 and 4) revealed systolic and diastolic murmurs over the pulmonic area and to the right of the lower part of the sternum. The other 2 cases had systolic murmurs over the pulmonic area only. The electrocardiogram in all instances showed a partial right bundle branch block which is so very frequently encountered in interatrial septal defect. The roentgenographic findings, identical in all 3 cases, were as follows: Considerable enlargement

* From the Department of Roentgenology and the Cardiovascular Research Group, The Mount Sinai Hospital, New York, N.Y.

of the heart to the right; moderate enlargement to the left; a considerable prominence of the pulmonary artery segment; and a laterally convex vascular

demonstrable disturbance of the surrounding lung fields (infiltration, atelectasis, etc.). Roentgenoscopically, pulsations were not discernible and only suggestive density



FIG. 1. A systolic and diastolic murmur was recorded to the right of the aortic area in a case of aberrant insertion of a right upper lobe pulmonic vein into the vena cava superior. The character is that of a continuous murmur of an arteriovenous fistula.

shadow parallel to the lower right cardiac border.

Although somewhat atypical in respect to the roentgenographic configuration, the clinical and laboratory findings of our cases are essentially those of uncomplicated interatrial septal defect. The right atrial enlargement in our cases was far greater than that of the right ventricle and pulmonary artery.

Continuous murmurs have been observed with aberrant insertion of pulmonic veins mostly in instances of complete drainage into coronary sinus or venae cavae. It appears difficult, however, to differentiate them from those present when there is an associated interatrial septal defect. In one instance of aberrant insertion of the right upper lobe pulmonic vein, a continuous murmur was audible to the right of the aortic area (Fig. 1). The murmur did not have the characteristics of aortic insufficiency but rather those of an arteriovenous fistula, such as patent ductus arteriosus. In addition the peripheral hemodynamics were not altered.

Roentgenographically aberrant pulmonic veins appear as a laterally convex falciform structure (Fig. 2, 3, 4, 5 and 6). They begin near the center of the respective lobe and extend to the point of insertion which in our 3 cases is the vena cava inferior. They have the homogeneous appearance of a vascular structure without

variations could be elicited by the Valsalva and Müller experiments.

Angiocardiography has proved to be the most useful diagnostic procedure for demonstrating as clearly as possible the abnormal function of the aberrant vessel. The angiocardiograms of Case A. R. in the

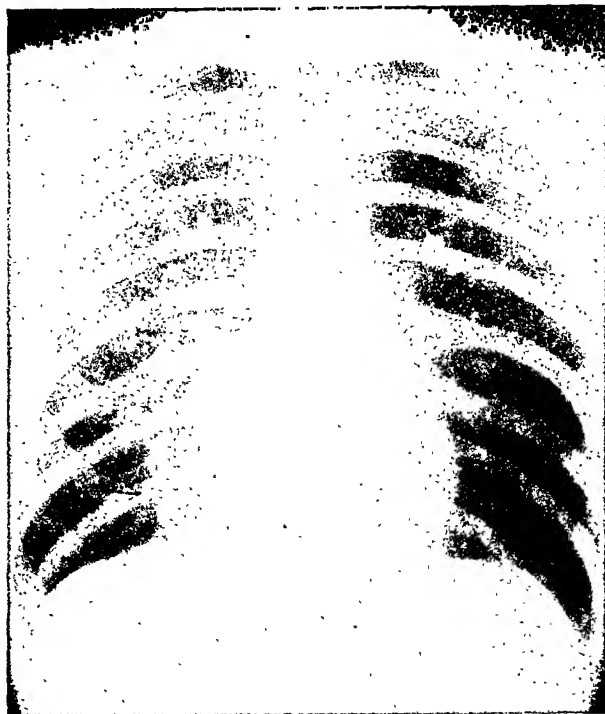


FIG. 2. A. R., male, aged twenty-four. Conventional roentgenogram. Considerable enlargement to the right, moderately prominent pulmonary artery and branches. The aberrant pulmonic vein is seen as a bandlike vascular shadow parallel to the lower right cardiac border (arrow).

posteroanterior and left anterior oblique views illustrate this clearly (Fig. 3 and 4). We found that once the observer is acquainted with the identity of this structure, he will not fail to diagnose it properly

somewhat uncertain. Baldwin, Cournand *et al.* did not mention the presence of a roentgen shadow corresponding to the aberrant pulmonary vein. It is possible that smaller aberrant or accessory pulmonary

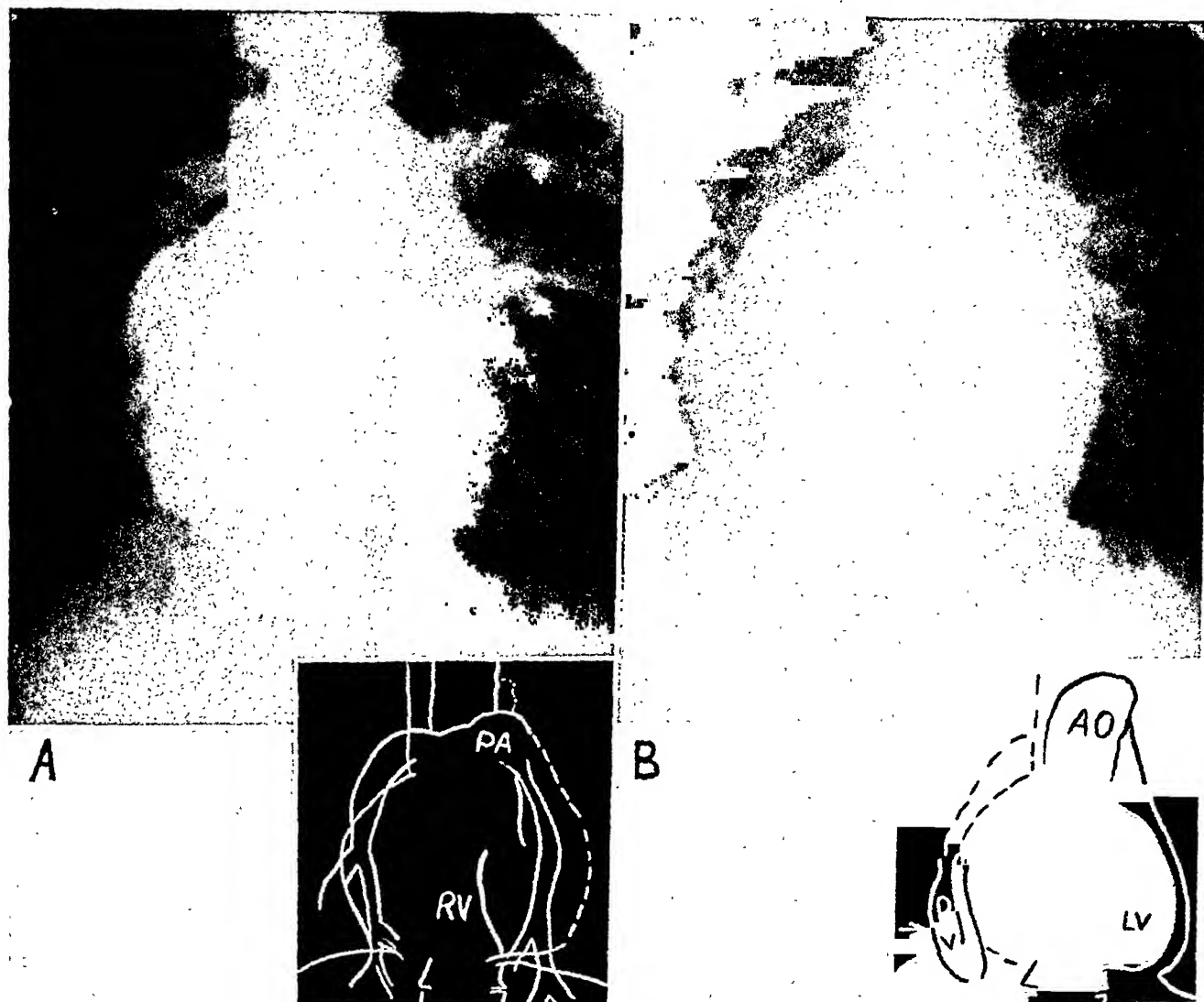


FIG. 3. Angiocardiogram, posteroanterior view. (A) One and one-half to two seconds after injection; marked right atrial enlargement pulmonary artery and branches considerably dilated. (B) Two seconds later during visualization of left atrium, ventricle and aorta; anomalous vascular shadow at right cardiac border demonstrated.

in future instances even from the conventional roentgenogram.

The aberrant insertion of a pulmonic vein into the right atrium by means of right heart catheterization has also successfully been diagnosed by Dr. J. de F. Baldwin and Dr. A. Cournand *et al.* With the tip of the catheter at a right lateral point of the atrium, an oxygen saturation similar to that of the arterial blood was obtained. However, the differentiation of such a finding from those possible in interatrial septal defect appears difficult and

veins or those in roentgenographically inopportune locations (e.g. behind the heart) might well escape detection. Vascular structures, unless angiocardiography or serial section roentgenography is used, have to be of a certain size and density before becoming roentgenographically demonstrable.

CONGENITAL ARTERIOVENOUS ANEURYSM OF THE LUNG

Clinically, arteriovenous aneurysms of the lung are now a frequently recognized

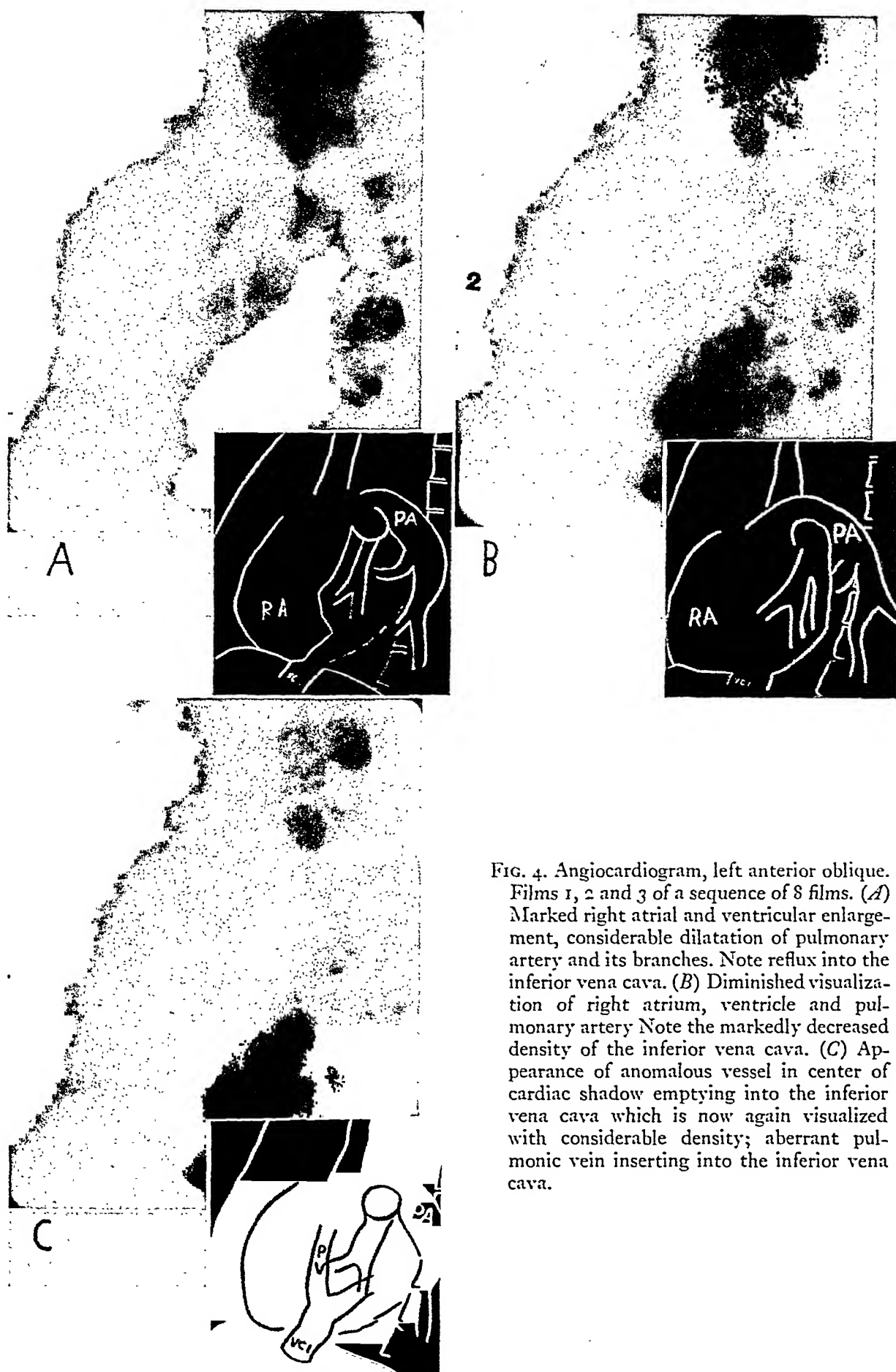


FIG. 4. Angiocardiogram, left anterior oblique.

Films 1, 2 and 3 of a sequence of 8 films. (A) Marked right atrial and ventricular enlargement, considerable dilatation of pulmonary artery and its branches. Note reflux into the inferior vena cava. (B) Diminished visualization of right atrium, ventricle and pulmonary artery. Note the markedly decreased density of the inferior vena cava. (C) Appearance of anomalous vessel in center of cardiac shadow emptying into the inferior vena cava which is now again visualized with considerable density; aberrant pulmonary vein inserting into the inferior vena cava.

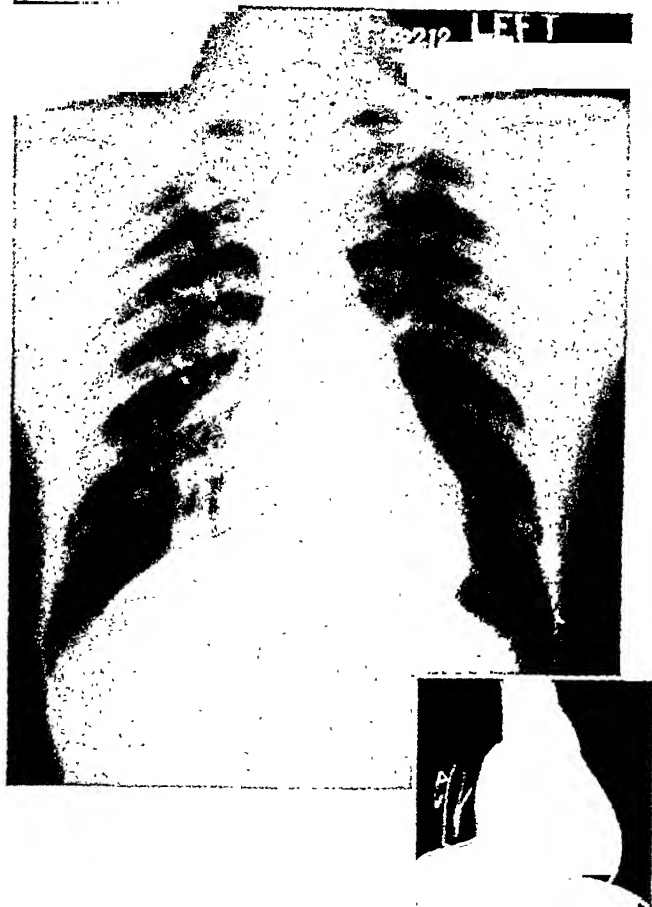


FIG. 5. G. H., male, aged twenty-two. Conventional roentgenogram. The heart is enlarged to the right and left, considerable prominence of pulmonary artery segment. Appearance of aberrant pulmonic vein and angiocardigraphic analysis almost identical to Case A. R. (see Fig. 2, 3 and 4).

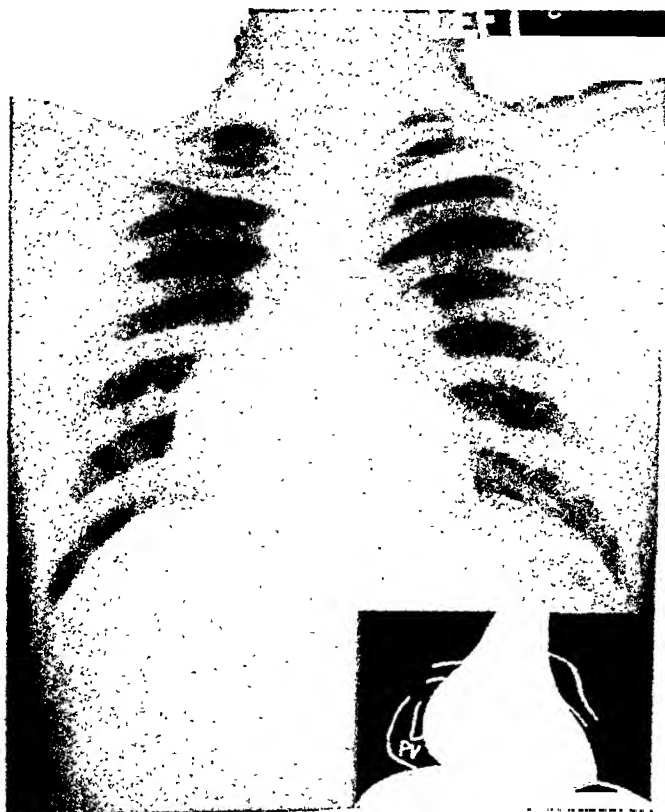


FIG. 6. H. R., male, aged twenty-six. Conventional roentgenogram. Marked enlargement of the heart to the right, considerable prominence of pulmonary artery, particularly its left main branch. Broad vascular shadow parallel to lower right cardiac border less dense than in Cases A. R. and G. H. (Fig. 2-5). Angiocardigraphy revealed this shadow to be demonstrated later than the pulmonary artery and communicating with the inferior vena cava.

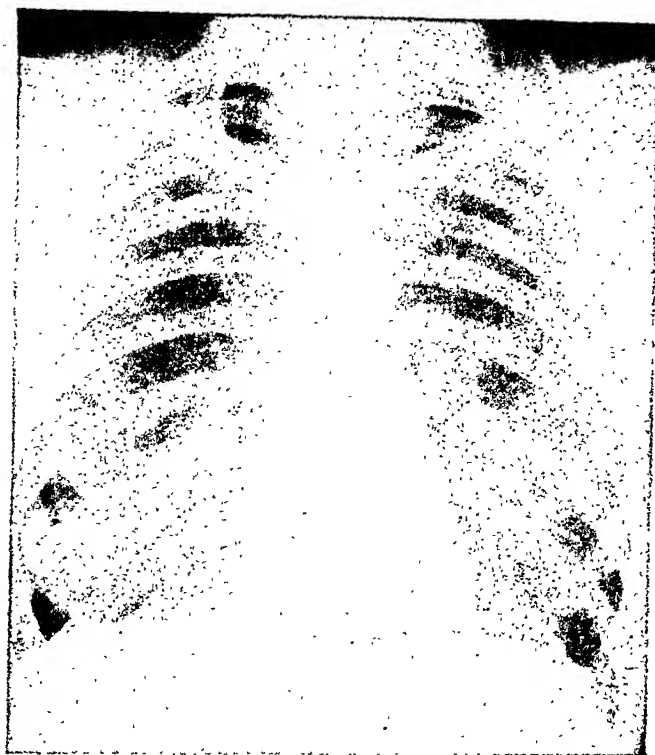


FIG. 7. R. W. G., male, aged twenty-three. Congenital arteriovenous aneurysm of right lower lobe. Cyanosis, clubbing and circulatory insufficiency. Conventional roentgenogram: large coil of vascular structures in right lower lobe apparently in continuity with right lower pulmonary artery and vein.

anomaly. Since they can be cured by lobectomy with complete disappearance of the often severe hemodynamic disturbance, their proper diagnosis is essential. The characteristic clinical features have been repeatedly discussed.^{3,6,7,11,12,16} The most commonly encountered signs and findings are cyanosis and clubbing, a pulmonic mass, and occasionally signs of circulatory insufficiency. Transient episodes of sudden unconsciousness, convulsions and transient neurological signs were present in several cases reported^{12,17} as well as in one of our cases. Sisson *et al.*¹⁶ reported such an epi-

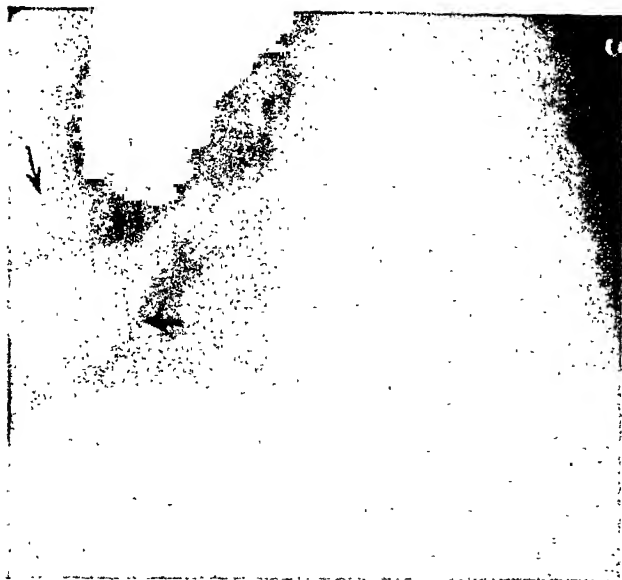


FIG. 8. Laminagram (8 cm. from anterior chest wall) suggests multichambered large aneurysm (lower arrow) filling via large branch of pulmonic artery and emptying through very wide pulmonic vein, just below and more proximal to the heart. A smaller racemose vascular structure (upper arrow) is suggested above the main aneurysm.



FIG. 9. Angiocardiogram. During visualization of right heart and pulmonary artery a large branch of the latter is seen to fill the vascular coil of the arteriovenous aneurysm; emptying into a dilated pulmonic vein a smaller racemose vascular structure is demonstrated cephalad. At operation an accessory pulmonic vein with aberrant insertion into the vena cava inferior was found in addition.

sode occurring two hours after an injection of diodrast which was introduced through an intracardiac catheter far into the right side of the heart. The outcome of the episode was fatal. They ascribed this to diodrast sensitivity and warned against its use in angiocardiography. The justification of this admonition, which was based on the experience of one single case, is, however, questionable particularly since over 1,500 cases subjected to angiocardiography have been reported without untoward result.¹⁹ It is particularly so since similar episodes have been observed by others to occur spontaneously in these pulmonary arteriovenous aneurysms. These transient complications may be caused by: cerebral

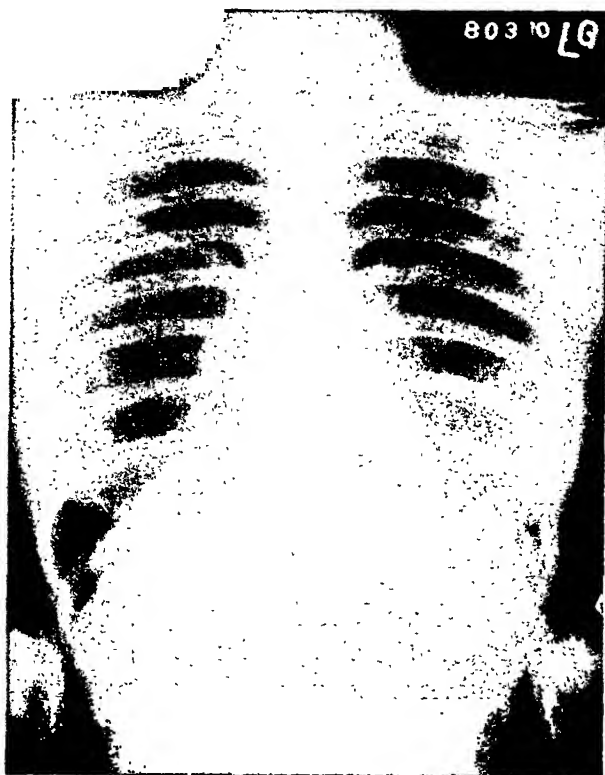


FIG. 10. F. M., female, aged twenty. Congenital arteriovenous aneurysm of right lower lobe. Conventional roentgenogram: Huge well circumscribed round mass in right lower lobe, apparently in continuity with branch of pulmonic artery. Very wide vascular shadow below pulmonic artery (pulmonic vein?). A second one in right cardiophrenic angle (vena cava inferior? Accessory aberrant pulmonic vein?).



FIG. 11. Angiocardiogram. During visualization of right heart and pulmonic artery the right lower branch of the latter is seen to fill a huge aneurysm of the right lower lobe. It empties through an enormously dilated pulmonic vein. Whether the vascular shadow in the right cardiophrenic angle is an accessory pulmonic vein or the vena cava inferior cannot be definitely stated.

anoxemia, cerebral sinus thrombosis, cerebral embolism from a thrombus within the arteriovenous aneurysm, or air embolism.¹²

The 3 patients with pulmonary arteriovenous aneurysm reported here presented cyanosis, clubbing of the digits and symptoms and signs of circulatory insufficiency. Precordial murmurs could be heard in none of them. Lobectomy in Case R. W. G. (Fig. 7, 8 and 9) revealed an aberrant insertion of the right lower lobe pulmonic vein into the vena cava inferior. In the third case (Fig. 12), an accessory pulmonary artery was found entering the apex to the right lower lobe. Marked improvement followed ligation of this vessel, although lobectomy was not performed. The second patient has not yet been operated upon (Fig. 10 and 11).

The roentgenographic appearance of congenital arteriovenous aneurysm of the

lung is rather characteristic: A serpiginous racemose cluster, or coil of structures, with parallel walls which suggest vascular structures in density and outline. This is especially true at the medial regions of the shadow where the venous and arterial components resolve themselves. The outlines of the structures are smooth and sharply demarcated except at the actual site of shunt where there is a variable amount of pooling. Pulmonary infiltration is absent but there may be some focal atelectasis. Little change is seen roentgenoscopically during the Valsalva or Müller experiments. Lindgren,¹² however, observed demonstrable changes with both procedures. Angiocardiography is the method of choice to demonstrate that the pulmonary shadow consists of vascular components. During the passage of the radiopaque substance through the heart and large vessels, the sequence of visualization is such that the pulmonary arterial



FIG. 12. J. E. M. Congenital arteriovenous aneurysm of right lower lobe. Cyanosis, clubbing, dyspnea, occasional blood expectoration and convulsions. Conventional roentgenogram: Inverted V-shaped vascular shadow of right lower lobe. Operation revealed accessory pulmonic artery leading to aneurysm.

component is seen first and the pulmonic veins later (about two and four seconds after the injection respectively). Serial sectional roentgenography also suggested that the pulmonary shadow was connected to the pulmonic vessels.

One of Lindgren's patients, operated upon by Craaford,¹² was found to have an accessory pulmonic artery deriving from the lobe above and leading to the aneurysm. Our 2 operated patients had an accessory pulmonary artery and aberrant pulmonic vein respectively. Although accessory and aberrant pulmonic vessels are not uncommon^{1,8,9,10,15} little mention is made of them in the literature either pertaining to regional anatomy or pulmonary arteriovenous aneurysms.

SUMMARY

1. The roentgenographic appearance and clinical recognition of aberrant insertion of pulmonic veins occurring in cases of interatrial septal defect are presented and discussed.

2. Diagnosis was established by angiocardiology with serial exposure technique.

3. It is suggested that these anomalies can be easily recognized once the observer is acquainted with their existence and roentgenographic appearance. Aside from angiocardiology, right vena caval catheterization should prove helpful in confirming the diagnosis. Right atrial, as well as right ventricular oxygen saturation figures, larger than those of the vena cava superior or inferior, might however just as well be due to the frequently associated interatrial septal defect.

4. In interatrial septal defect, the association with aberrant insertion of one pulmonic vein is compatible with long life. Only in extremely rare instances is the abnormal insertion of more than one into the main tributaries of the right atrium compatible with life beyond infancy. The almost invariably associated interatrial septal defect is above and posterior to the fossa ovalis (overriding vena cava superior).

5. The roentgenographic appearance and diagnosis of congenital pulmonic arteriovenous fistula by means of angiocardiology has been discussed. The apparently frequent occurrence of aberrant and accessory pulmonary arteries and veins has been stressed. This point should be of particular importance to thoracic surgeons undertaking lobectomy for the cure of this anomaly.

Mt. Sinai Hospital
New York 29, N. Y.

REFERENCES

1. ARCE, J. Accessory pulmonary artery probably arising from abdominal aorta. *J. Thoracic Surg.*, 1943, 12, 548-552.
2. ATKINSON, W. J., JR., DEAN, J. L., KENNERDELL, E. H., and LAMBERTSEN, C. J. Multiple anomaly of human heart and pulmonary veins. *Anat. Rec.*, 1940, 78, 383-388.
3. BEIERWALTES, W. H., and BYRON, F. X. Pulmonary arteriovenous aneurysm with secondary polycythemia. *J.A.M.A.*, 1947, 134, 1069-1072.
4. BRODY, H. Drainage of the pulmonic veins into the right side of the heart. *Arch. Path.*, 1942, 33, 221-240.
5. BROWN, J. W. Congenital Heart Disease. John Bale, Ltd., London, 1939.
6. BURCHELL, H. B., and CLAGETT, O. T. Clinical syndrome associated with pulmonary arteriovenous fistulas, including a case report of a surgical cure. *Am. Heart. J.*, 1947, 34, 151-162.
7. CABOT CASE NO. 33251. *New England J. Med.*, 1947, 236, 951.
8. COMPERE, D. E., and FORSYTH, H. F. Anomalous pulmonary veins. *J. Thoracic Surg.*, 1944, 13, 63-66.
9. HARRIS, H. A., and LEWIS, I. Anomalies of the lungs with special reference to the danger of abnormal vessels in lobectomy. *J. Thoracic Surg.*, 1940, 9, 666-671.
10. HUGHES, C. W., and RUMORE, P. C. Anomalous pulmonary veins. *Arch. Path.*, 1944, 37, 364-366.
11. JONES, J. C., and THOMPSON, W. P. Arteriovenous fistula of lung; report of patient cured by pneumonectomy. *J. Thoracic Surg.*, 1944, 13, 357-373.
12. LINDGREN, E. Roentgen diagnosis of arteriovenous aneurysm of lung. *Acta radiol.*, 1946, 27, 585-600.
13. PALTAUF, R. Ueber einen seltenen Defekt in der Vorhofscheidewand. *Verhandl. d. deutsch. path. Gesellsch.*, 1913, 16, 249.

14. Presented at a meeting of the New York Heart Association, 1947.
15. PRYCE, D. M. Lower accessory pulmonary artery with intralobar sequestration of the lung. *J. Path. & Bact.*, 1946, 58, 457-467.
16. SISSON, J. H., MURPHY, G. E., and NEWMAN, E. V. Multiple congenital arteriovenous aneurysms in the pulmonary circulation. *Bull. Johns Hopkins Hosp.*, 1945, 76, 93-111.
17. SMITH, H. L., and HORTON, B. T. Arteriovenous fistula of the lung associated with polycythemia vera; report of case in which diagnosis was made clinically. *Am. Heart J.*, 1939, 18, 589-592.
18. SUSSMAN, M. L., GRISHMAN, A., and STEINBERG, M. F. Newer concepts in diagnosis of congenital heart disease. *Am. J. Dis. Child.*, 1943, 65, 922-936.
19. SUSSMAN, M. L., and GRISHMAN, A. A discussion of angiocardiology and angiography. In: *Advances in Internal Medicine*. Vol. II, pp. 102-172. Interscience Publishers, New York, 1947.
20. SUSSMAN, M. L., STEINBERG, M. F., and GRISHMAN, A. Multiple exposure technique in contrast visualization of the cardiac chambers and great vessels. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 46, 745-747.
21. SUSSMAN, M. L., STEINBERG, M. F., and GRISHMAN, A. Rapid film changer for use in contrast angiocardiology. *Radiology*, 1942, 38, 232-233.
22. WHITE, P. D. *Heart Disease*. Third edition. Macmillan Company, New York, 1944.



THE TIME FACTOR IN CEREBRAL ANGIOGRAPHY AND AN AUTOMATIC SERIOGRAPH*

By J. M. SANCHEZ-PEREZ, M.D., and RAY A. CARTER, M.D.

University of Southern California

LOS ANGELES, CALIFORNIA

THE TIME FACTOR

INVESTIGATORS who have been interested in the field of cerebral angiography have long ago realized the importance of visualizing the three main different stages in the cerebral circulation.

Egas Moniz,^{2,3} as well as ourselves,^{6,7} has emphasized upon different occasions the importance of the capillary phase.

Hodes, Perryman and Chamberlain,⁴ in their review of cerebral angiography, state that the difficulty in obtaining the capillary phase, or in other words a complete angiogram, is that of rapid and precise changing of the cassettes.

Every complete angiogram is formed by one arterial stage, one capillary stage, and one venous stage. The venous stage is clearly divided in two phases, first and second.⁶ Those three stages of cerebral angiography are accomplished in four and one-half seconds, provided no extraneous factors interfere with the circulation.⁷

The time consumed in the injection, the amount of opaque substance and the management of the pressure employed during the injection are of great importance. Too large amounts of opaque substance contribute to interference with the different stages, or with the phases of the venous stage by visualizing too much of the circulatory system of the brain at the same time. The pressure of the injection has a direct effect upon the concentration of the medium and upon the sharp visualization of the vessels.

We may consider the opaque substance as a "liquid segment" which must be followed in its passage through the vascular system of the brain and recorded on films, in the different stages.

Since 1931, we (J. M. S-P.) have injected various amounts of opaque substance and since 1936 have decided that the optimal volume is 6 cc. when the injection is made in the internal carotid artery, while 8 cc. is required in the common carotid artery.

We have found that the most favorable interval between exposures results from obtaining six films in four and one-half seconds, this particular length of time being that required normally for the "liquid segment" to travel from the common carotid artery in the neck to the internal jugular vein in the neck.⁵ With those constants, the six roentgenograms taken will provide the component elements of a complete cerebral angiogram from all points of view (Fig. 1).

Very often the circulation in one or in both cerebral hemispheres takes place in less time than that considered normal.^{1,5,8} In these cases the blood leaves the brain sooner due to two possibilities: First, a rapid rate of circulation; second, a shortcut shortens the path, decreasing the time required for passage of the "liquid segment" through the cerebral hemisphere (Fig. 2). Serial roentgenograms will prove which has occurred. Very often the rate of circulation is abnormally slow (Fig. 3). In that case, the fifth picture that should correspond to the phlebography of the second phase, still reveals the phlebography of the first phase, or even the arterial stage, as in one case of carotid thrombosis (Fig. 4). In such a case, six roentgenograms still present a complete angiogram of the side injected. The slowing of the circulation can be also of two types. One, in which the vascular pathways have been enlarged, as in certain types of arteriosclerosis, or in

* From the University of Southern California Medical School and the Departments of Neurosurgery and Radiology of the Los Angeles County Hospital. Presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

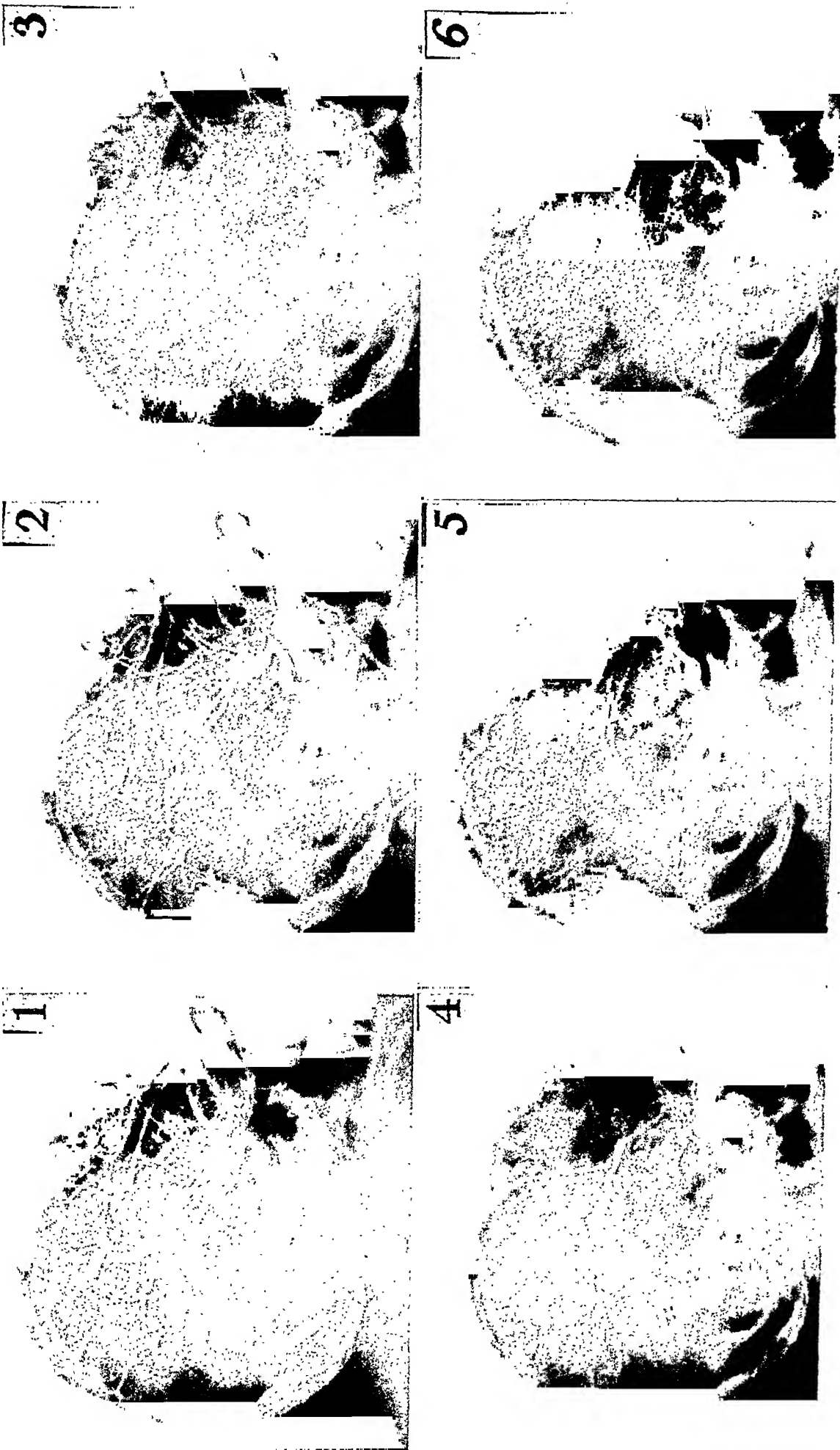


FIG. 1. Complete angiogram, approximately normal.

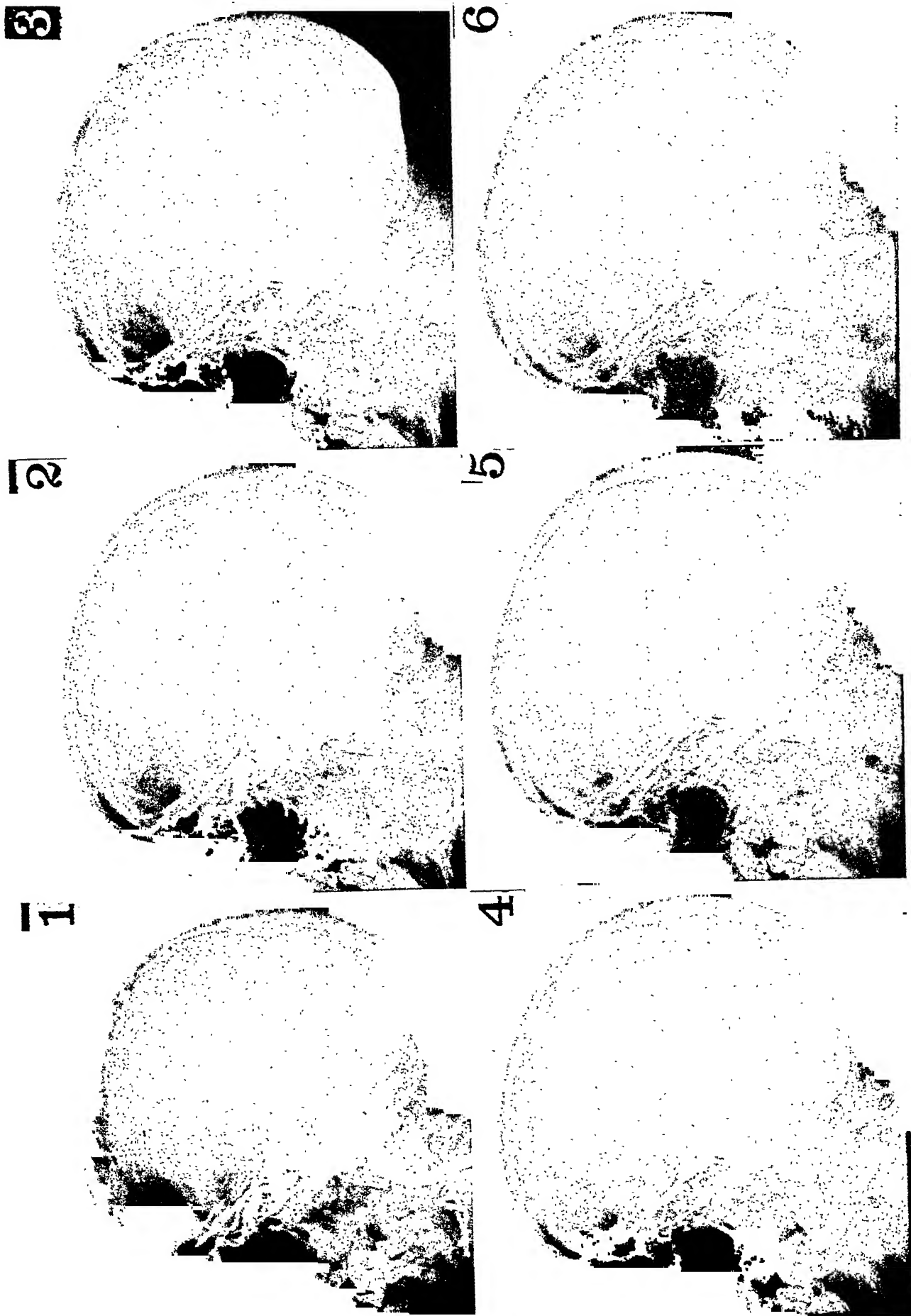


FIG. 2. The opaque medium passes from the carotid artery to the cavernous sinus, and ophthalmic veins, leaving the cranial cavity in 2.5 seconds without increasing the rate of flow.

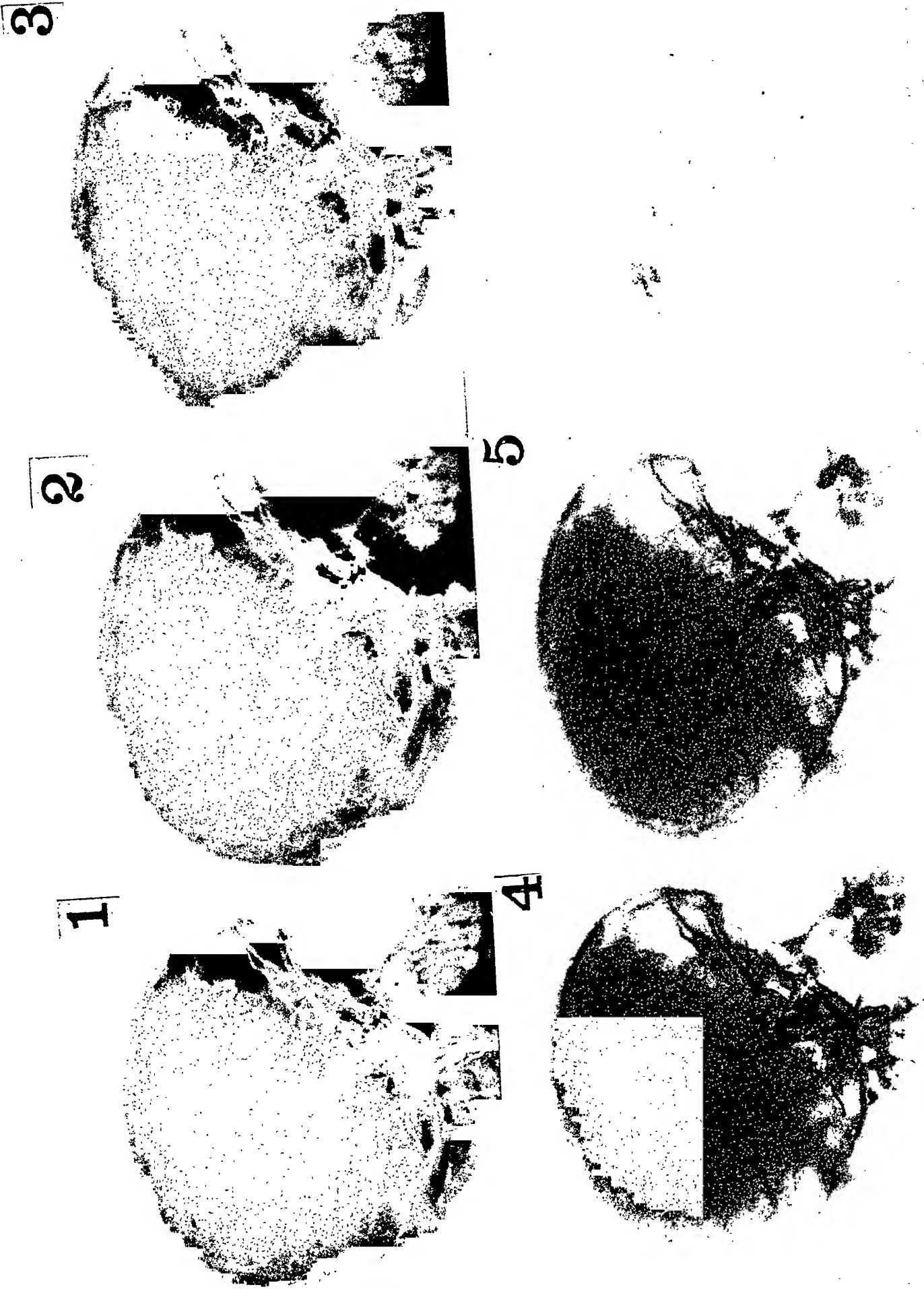


FIG. 3. Complete angiogram in a congenital vascular malformation in the frontal region.

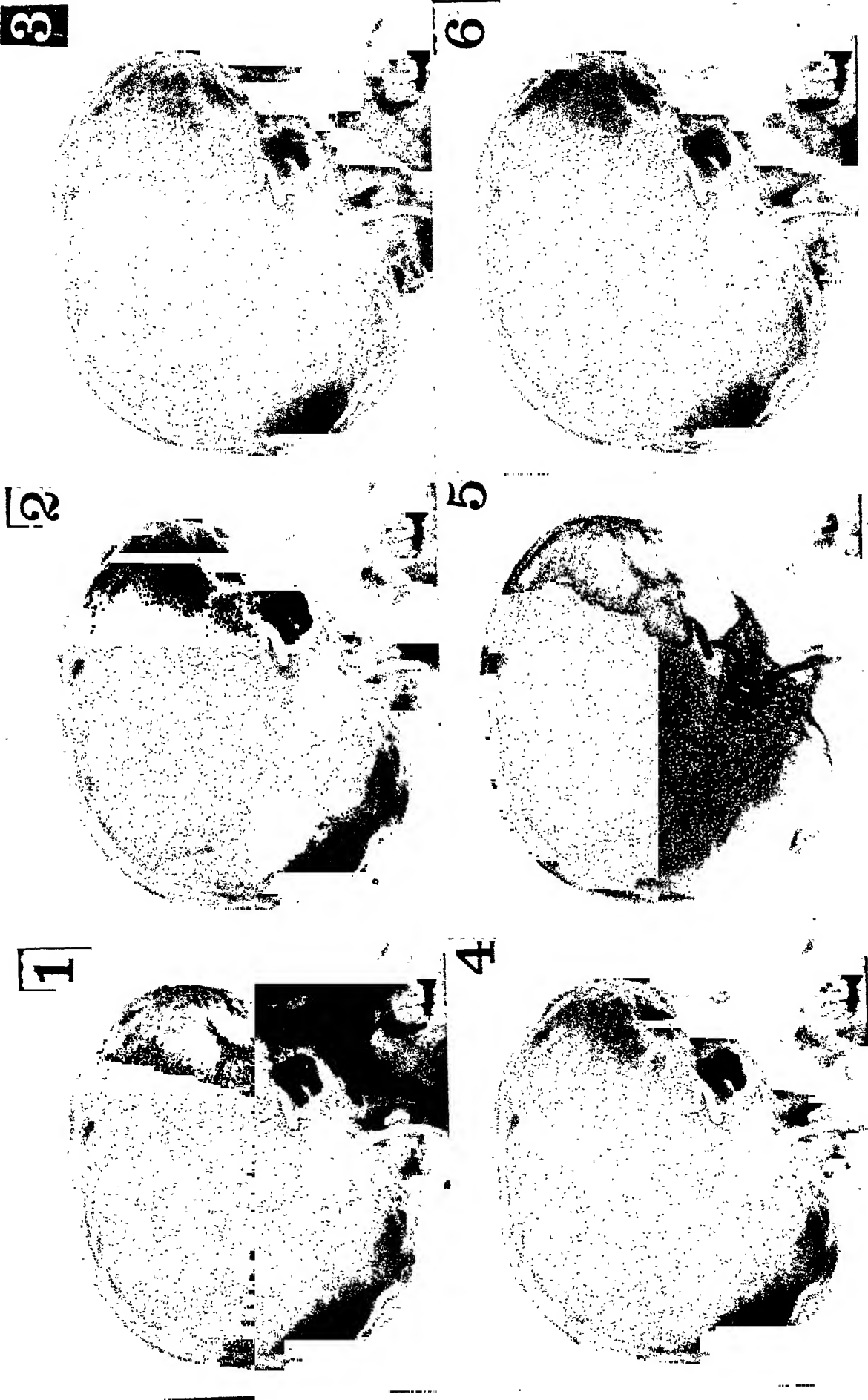


FIG. 4. Internal carotid thrombosis. Opaque substance does not progress in 4-5 seconds of the exploration.

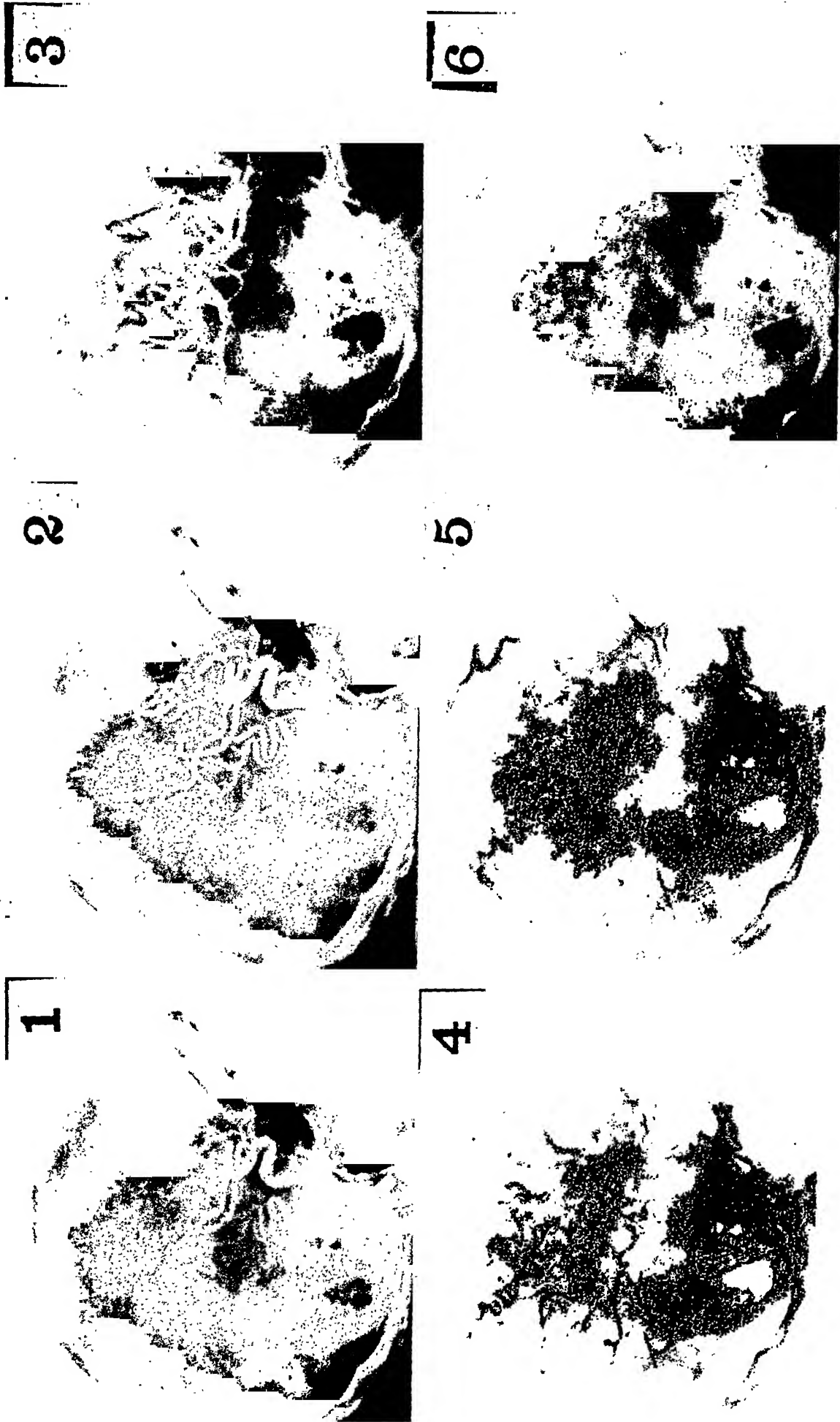


FIG. 5. Complete angiogram in a generalized vascular dystrophy.

varicosities of the brain. The other, in which the blood is flowing definitely more slowly than normal as in certain types of congenital vascular malformations, generalized arteriosclerosis with rigidity of the arteries, tumors or other diseases in which a collateral circulation has been established after a vascular lesion (Fig. 5).

To obtain a complete angiogram when there is slow circulation, the six films are made with standard speed and the usual interval between exposures. The collateral circulation conducts the opaque substance through unusual channels; for instance, when a lesion prevents the sigmoid sinus from accomplishing its function of draining the surface of the brain, the blood will leave through the middle cerebral vein. These considerations made us decide to use six exposures. These six roentgenograms are taken always in the same period of time so that abnormal cases can be compared with the normal. In a normal angiogram the last film will not show any opaque substance remaining in the circulatory system of the brain. However, if the rate of circulation is diminished, the last film will show the presence of opaque substance wherever it may remain.

From the set of six serial roentgenograms we will choose for special study those which depict best the three stages, namely, arteriography, the capillary stage, and the phlebography of the first phase and the second phase. These two phases of phlebography, even though they are included in the venous stage are normally separated chronologically by approximately one-half second. Which of these roentgenograms will be best will depend upon the rate of the circulation. Having in mind the length of time between these principal stages, we can be acquainted with the physiological facts independently of the possible distortion of the roentgenographic anatomy. At the risk of being repetitious, we wish to emphasize that the angiograms furnish, if they are properly taken, not only anatomical or pathological information but also physiological information.

This, for example, in cases of concussion of the brain, can be of tremendous importance.

The surgical approach actually adopted is the one that interferes least with the cerebral circulation, and an effort is made to keep the pressure of injection slightly above the systolic pressure of the patient. The most important detail is to know the amount of the opaque substance injected and the length of time employed in injection. The medium should flow freely. The artery injected should not be displaced, clamped, twisted, or temporarily ligated, because these manipulations, if they can be resisted by the patient, have a definite influence on the circulatory process, especially the rate of flow.

It is important to inject both sides of the brain. Very often two completely independent pathological conditions are found, one in each hemisphere. Also, because physiologically an abnormality in the rate of circulation on one side must be accompanied by compensatory, vicarious and physiologically abnormal condition in the other hemisphere.¹ This happens in some cases of thrombosis of the internal carotid artery, in which the obstruction does not interfere with the function of the circle of Willis, consequently with none or few neurological symptoms.

We have observed 2 cases in which the angiograms were normal in timing and normal anatomico-chronologically, but in which the opaque substance was passed from the arterial tree to the capillaries and from them to the inferior sagittal sinus and the great cerebral vein of Galen, and also to the middle cerebral vein. This is abnormal or at least infrequent because the blood customarily goes from the capillaries to the descending and ascending veins first. It is only one and one-half seconds after that stage that the blood reaches the aforementioned sinuses. To make ourselves clear, we should say that even if the whole circulatory sequence were in four and one-half seconds and anatomically there was no evidence of any abnormality, the pathway

of blood was unusual, and that this abnormality may be related to the clinical findings (clinical history and angiogram).

AN AUTOMATIC SERIOGRAPH

The most frequent manner in which serial roentgenograms are obtained in cerebral angiography is the manual shifting of cassettes on conventional roentgen-ray equipment. It is difficult to accomplish

to place three conventional cassettes but because of their thickness, more than three cassettes appeared impracticable.

In surveying this equipment, it became evident (R. A. C.) that the spring tension device which shifted a new cassette into position with the removal of the exposed one, could also provide the spring tension to maintain proper contact between the films and the intensifying screens within

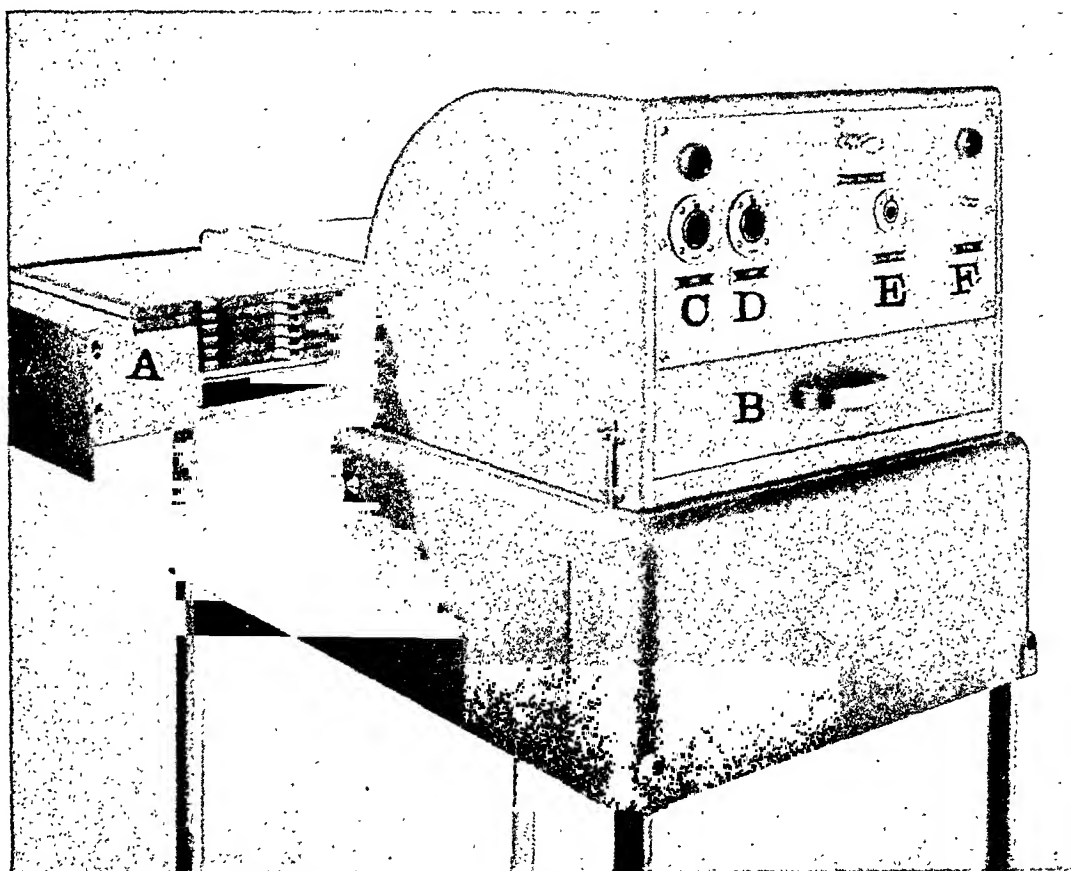


FIG. 6. An automatic serigraph. *A*, loading drawer; *B*, removing drawer; *C*, line switch; *D*, timer switch; *E*, foot switch; *F*, button switch.

this shift under three seconds of time, which imposes a limit on the films available during the period of the passage of the blood through the brain.

One of us (J. M. S-P.) devised a serigraph in which three exposures were available during the period of the passage of the blood through the brain. This device was in the form of a cassette magazine of the appropriate thickness to lie upon the roentgen-ray table and permit roentgenograms with the patient in a comfortable position. In this device it was practicable

the cassette. This would permit a cassette of one-half the thickness of the conventional one, thereby permitting six cassettes to be placed within the original cassette holder.

Such cassettes were made by V. L. Frickman of the Engineering Department of the University of Southern California, aided by a grant by Peter Lindstrom, M.D.

In making these cassettes it appeared practicable to provide protection of underlying films from secondary radiation by a thin layer of lead inside the back of each cassette rather than by the separate lead

trays which underlay the cassettes in the original device. In practice, this protection proved sufficient. A handle on the cassette facilitating manual removal replaced the handle on the protective tray of the original design.

It was desired to develop from this relatively simple seriograph one fully automatic in operation (Fig. 6), both as to timing of exposures and shifting of cassettes so that the serial exposures would be made at the fixed interval of time most appropriate for cerebral angiography. It was desired also to reduce to the minimum the personnel necessary to conduct the examination. It was desired to place the device in a portable cabinet whereby the examination could be done at any adequate roentgenographic station.

The first requirement was a switch plug installed in the control stand of the roentgen-ray generator to be employed in parallel with its timer.

The seriograph was designed to have the following features:

A two-conductor cable was provided to connect the seriograph electrically through the above-mentioned switch-plug on the control stand of the generator.

A three-conductor cable was provided to connect the seriograph to a source of electric current 110 volts, 60 cycles, and to ground.

An exposure activating device and an automatic cassette-shifting device were provided to operate so that following each roentgen-ray exposure, the cassette was removed and an unexposed one injected into position for the next exposure, the second exposure made and this series continuing until the completion of six exposures. This device provided that the successive exposures should be made at the predetermined fixed interval of time. Two such intervals were chosen, as follows:

Seven-tenths of a second for cerebral angiography and 2.5 seconds for cardiography. The exposure time was to be set at the timer of the control stand of the roentgen-ray generator and was required to be 0.1 second or less.

The cassette shifting device automatically moved the cassettes after exposure from the loading magazine to a rubber-lined drawer from which they were to be later removed for processing.

Devices to control the starting of the seriograph were developed:

a. A foot switch in series with the operative wiring of the seriograph was provided to be operated by the surgeon to permit the starting of the series of exposures. This insured that roentgenograms could not be made until the surgeon was ready. Operating this switch lights a signal indicating to the technician at the seriograph that the surgeon is ready to proceed.

b. A switch button also in series with the operative circuit of the seriograph is employed by the technician stationed there to start the series of exposures.

The device was mounted on a wheeled cabinet to give adequate stability and transportability.

Its height was made adjustable so that it could be adapted to various conventional roentgen-ray tables.

A protective lead layer was included within the cabinet of the seriograph for protection of the technician.

The cassettes were provided with inbuilt lead numbers to designate the chronological order of exposures.

OPERATION OF THE AUTOMATIC SERIOGRAPH

This procedure is divided in two parts, roentgenological and surgical. The number of persons necessary for the roentgenological part can be reduced to two, roentgenologist and technician. The technician's part will be:

To adjust the automatic seriograph to the roentgen-ray table.

To connect the seriograph to the electric current.

To connect the seriograph with the timer of the generator control stand.

To adjust the roentgenographic settings at the control stand so that an exposure time of 0.1 second or less is obtained. Kilovolts and milliamperes as well as focal distance should be decided, having in mind

the 0.1 second exposure time requirement.

The roentgenologist will supervise the positioning of the patient.

Following this, the technician will start the rotating anode after the surgeon requires it and be ready to press the button when given a signal by the surgeon.

The surgical part can be, of course, over-emphasized. It seems to us that a quite safe procedure is to have the patient lie on the roentgen-ray table with the head over the seriograph. Under surgical conditions, the neck will be opened about 1 inch above and parallel to the clavicle and the common carotid artery dissected, unless blind puncture is used.

At this time, the surgeon will have the needle in the left hand, the syringe in the right hand and will ask the technician to start the rotating anode. He will then step on the foot switch and start the injection. When the injection is completed, he will indicate with the word "now" that the technician is to push the starting button. The six roentgenograms will then be automatically exposed in four and one-half seconds, the technician will take the cassettes to be developed and the surgeon will keep a piece of gauze in the wound and be ready for the second injection if required for the anteroposterior views.

Local anesthesia will eliminate the necessity of an anesthetist and although an

assistant to the surgeon and a nurse are desirable, in extraordinary situations, one of us (J. M. S-P.) did perform a complete angiogram with no other help than that of a roentgen-ray technician.

1200 North State St.
Los Angeles 33, Calif.

REFERENCES

1. DUEKER, H. W., and SANCHEZ-PEREZ, J. M. Carotid-cavernous communication of traumatic etiology. *Bull. Los Angeles Neurol. Soc.*, 1947, 12, 97-103.
2. EGAS MONIZ. L'angiographie cérébrale. Masson & Cie, Paris, 1934.
3. EGAS MONIZ, ALMEIDA LIMA, and PEREIRA CALDAS. Angiographies en série de la circulation de la tête. *Rev. neurol.*, 1934, 1, 489-510.
4. HODES, P. J., PERRYMAN, C. R., and CHAMBERLAIN, R. H. Cerebral angiography. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1947, 58, 543-583.
5. RANEY, R., SANCHEZ-PEREZ, J. M., and RANEY, A. A. The role of complete angiograms in neurosurgery. Presented at the Harvey Cushing Society Meeting in August, 1948 (to be published).
6. SANCHEZ-PEREZ, J. M. Cerebral angiography, *Surgery*, 1941, 10, 535-552.
7. SANCHEZ-PEREZ, J. M. Cranial seriograph and its utility in neurologic radiology for cerebral angiography. *Surgery*, 1943, 13, 661-666.
8. SHENKIN, H. A., SPITZ, E. B., GRANT, F. C., and KETY, S. S. Physiologic studies of arteriovenous anomalies of the brain. *J. Neurosurg.*, 1948, 5, 165-172.



NON-PATHOLOGIC VARIATIONS IN RELATIONSHIP OF THE UPPER CERVICAL VERTEBRAE*

By LESTER W. PAUL, M.D., and WILLIAM W. MOIR, M.D.

MADISON, WISCONSIN

IN frontal roentgenograms of the cervical spine made through the open mouth or using the moving jaw technique as described by Jacobs,³ the first and second vertebrae are usually well demonstrated. The latter method has been found useful as a routine procedure in examining the cervical spine. In viewing such roentgenograms we have encountered a number of instances in which the first cervical vertebra appeared to be displaced laterally on the second so that the space between the dens and the articular mass of the atlas was much wider on the one side than on the other. Since this finding occurred in individuals who were being examined for non-traumatic as well as traumatic conditions, it was decided to investigate the problem further to determine (1) the frequency of occurrence of such lateral asymmetry in normal persons, (2) the effect of distortion caused by improper positioning of the patient during roentgenography, and (3) the effects of lateral bending and forceful flexion in producing a lateral gliding motion in the facet joints between these two vertebrae.

ANATOMY

There are three diarthrodial joints between the atlas and axis; two are lateral and are formed by the articular processes of the adjacent vertebrae while the third is anterior and is formed by the posterior surface of the anterior arch of the atlas and the anterior surface of the dens. The alignment of these two vertebrae is maintained by anterior and posterior ligaments and also by a strong transverse ligament. This latter structure has been called one of the most important in the body for upon its integrity our lives largely depend. Attached at either end to a tubercle on the

inner side of the lateral mass of the atlas, it extends across the ring of the atlas directly behind the dens from which it is separated by a bursa or joint cavity. It serves to keep the dens in close apposition to the anterior arch of the atlas. Further support is lent by two other ligamentous structures, (1) a fasciculus of vertical fibers which extends from the root of the dens upward to the basilar border of the foramen magnum, some of its fibers arising from the transverse ligament, and (2) the atlanto-dental articular capsule, a tough membrane completely surrounding the apposed articular surfaces of the atlas and dens.

According to Morris' Anatomy the chief and characteristic motion between the atlas and axis is rotation with the dens as a pivot. In addition, forward and backward movements and some lateral flexion are permitted. A lateral gliding motion is not described.

LITERATURE

Relatively few observations have been made on the significance of lateral asymmetry of the atlas and axis as seen in frontal roentgenograms. Pancoast *et al.*⁴ reproduce the roentgenograms of a cervical spine showing an apparent lateral subluxation of the first on the second cervical vertebra and express the opinion that it represents a variation of the normal. Dankmeijer and Rethmeier² report some investigations on the subject. They concluded that lateral mobility of the atlas in relation to the axis was possible and advised caution in the interpretation of an asymmetric position of the dens for the diagnosis of atlas subluxation. This was recognized in part by Coutts¹ who says that the sign of lateral displacement of the atlas (with reference to atlanto-axial dislocations) is subject to

* From the Department of Radiology, University of Wisconsin Medical School and the State of Wisconsin General Hospital. Presented at the Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16-19, 1947.

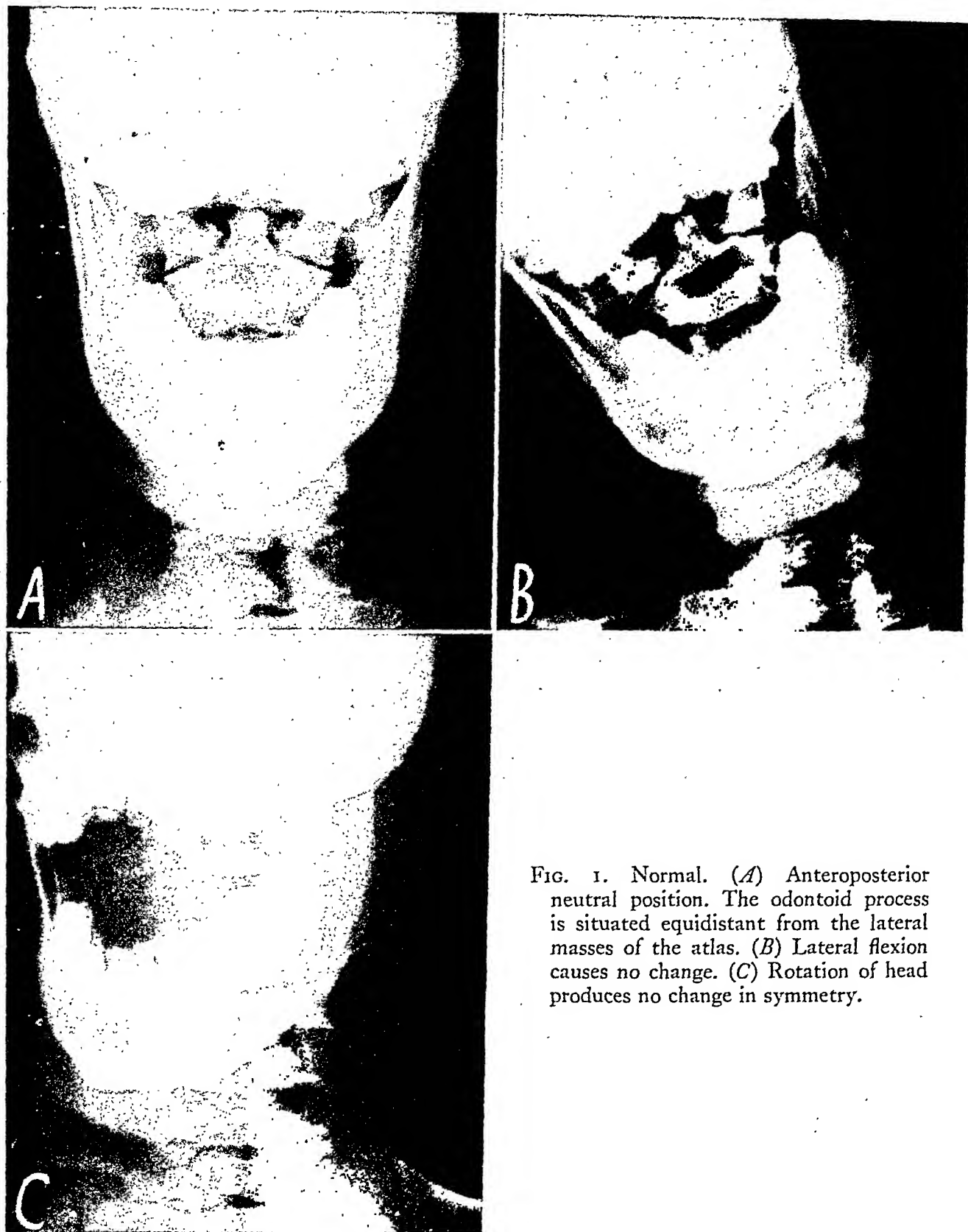


FIG. 1. Normal. (A) Anteroposterior neutral position. The odontoid process is situated equidistant from the lateral masses of the atlas. (B) Lateral flexion causes no change. (C) Rotation of head produces no change in symmetry.

many errors. The first cervical vertebra has a normal lateral mobility on the second as great as that seen in most subluxations. Moreover, whenever rotation is present the second cervical vertebra is foreshortened in the anteroposterior view, giving the appearance of lateral displacement to one or both

sides. In order to give significance to this appearance of lateral displacement Coutts believes that the head must be held erect on the spine and both lateral masses must be displaced laterally with respect to the dens. Under these conditions a unilateral displacement represents a pathologic fixa-

tion in a position within the normal range of motion. It might be mentioned in passing that our investigation of normals indicates that even when the head is held in neutral position, no pathologic significance can be attached to lateral movement

absence of a fracture is an increased anterior atlanto-dental interval as seen in the lateral view of the spine. With these observations we are in general agreement.

Others have ascribed considerable diagnostic significance to lateral asymmetry of

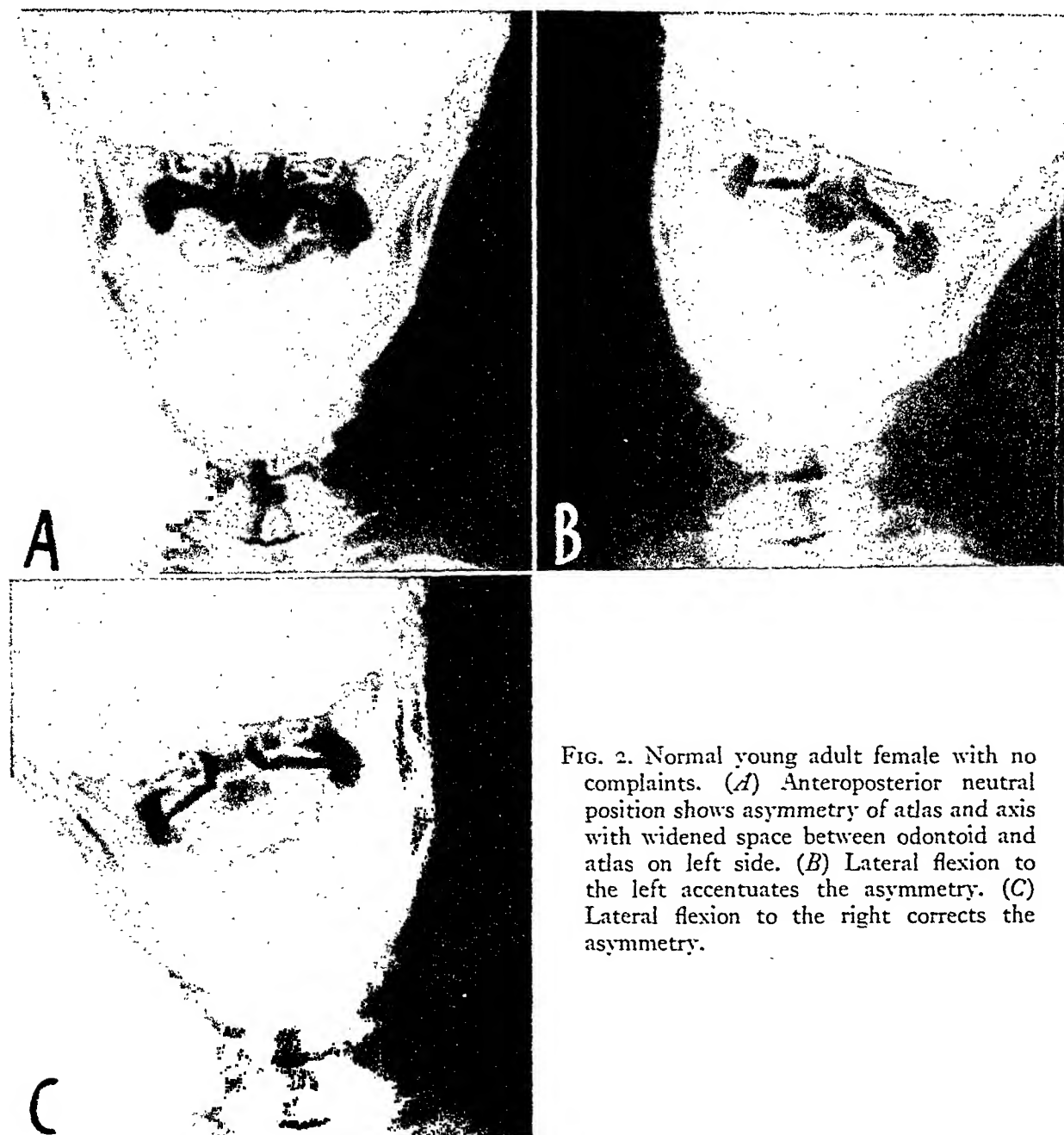


FIG. 2. Normal young adult female with no complaints. (A) Anteroposterior neutral position shows asymmetry of atlas and axis with widened space between odontoid and atlas on left side. (B) Lateral flexion to the left accentuates the asymmetry. (C) Lateral flexion to the right corrects the asymmetry.

of the articular masses on the dens as long as both masses move in the same direction. Coutts also remarks that a bilateral displacement of the atlantal masses in opposite directions indicates a fracture of one of the arches of the atlas and that the only pathognomonic sign of subluxation in the

these two vertebrae as exemplified by Plaut⁵ who, in discussing fractures of the atlas, remarks, "In a dislocation of the atlas without fracture the lateral masses would shift for the same distance and in the same direction; the relation of the lateral masses to the odontoid process aids

in determining the nature of the lesion" (whether a dislocation is present with or without fracture of the atlas).

ROENTGEN STUDIES

In anteroposterior roentgenograms made with the techniques mentioned earlier, nor-

sides (Fig. 1). In the variation under discussion the atlas appears to be shifted laterally on the axis for a variable distance (Fig. 2). As a result the space between the dens and one articular mass is appreciably wider than on the opposite side and a corresponding lateral shift of the articular

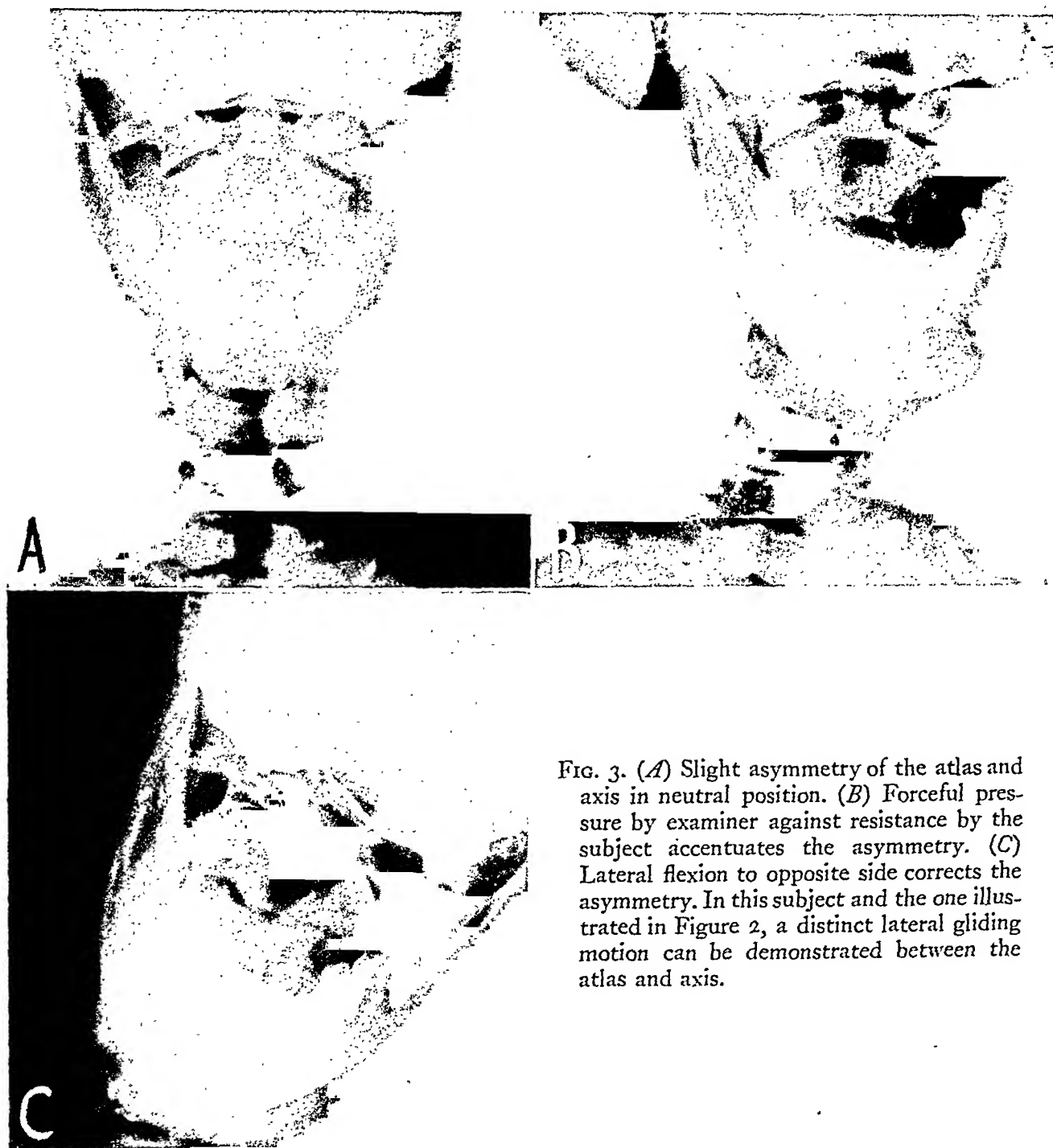


FIG. 3. (A) Slight asymmetry of the atlas and axis in neutral position. (B) Forceful pressure by examiner against resistance by the subject accentuates the asymmetry. (C) Lateral flexion to opposite side corrects the asymmetry. In this subject and the one illustrated in Figure 2, a distinct lateral gliding motion can be demonstrated between the atlas and axis.

mally the shadow of the dens is visible lying between the lateral masses of the atlas and equidistant from them. The articulating facet surfaces of the atlas and axis are of symmetrical appearance on the two

masses is evident.

In order to determine the frequency of occurrence of this asymmetry a group of 25 apparently normal students was examined. None of these had any present or past

complaints referable to the neck and gave no history of antecedent injury. Anteroposterior and lateral roentgenograms with the head in neutral position were obtained. Sixteen of the 25 were normal. The remaining 9 showed varying degrees of lateral asymmetry.

Next a smaller group of 9 normal individuals, mostly resident physicians and other hospital personnel, was examined. Roentgenograms of these were obtained in five positions: (1) with the head in neutral position, (2) with the head in maximum lateral flexion to the right and then to the left, and (3) with the head upright but with the chin rotated to the left and also to the right. In this group, 3 showed lateral asymmetry with the head in neutral position. This tended to be increased by flexing the head to the side of the shift and to be corrected by flexion to the opposite side (Fig. 2 and 3). Two showed an asymmetry only on maximum lateral flexion to one side or the other. In those roentgenograms made with the cervical spine straight but with the chin rotated to either side, no significant change in relationship of the dens to the lateral masses could be demonstrated. Variations in alignment of the articular facets and in the width of the facet joint spaces was obvious due to the rotatory nature of the motion which is characteristic for these joints.

DISCUSSION

These experiments tend to show that minor degrees of rotation of the head such as might be encountered in practice due to improper positioning of the patient can be disregarded as a cause for lateral asymmetry of these two vertebrae. They also reveal that an appreciable number of normal persons may show such a lateral offset upon routine roentgen examination. Further, they support the conclusion that in some individuals lateral motion of appreciable degree may occur between the atlas and axis. In such a person unilateral muscle spasm might cause a distinct variation in alignment upon roentgen examination. The

fact that it is found in neutral position of the head, however, makes it impossible to attach any diagnostic significance to the finding regardless of whether there is a history of injury or not, or whether there is clinical evidence of muscle spasm. As indicated by Coutts, the surest sign of bilateral atlanto-axial subluxation, whether traumatic or spontaneous, in the absence of fracture, is an increased atlanto-dental interval as demonstrated in lateral roentgenograms of the neck.

There are several possible causes of the lateral asymmetry. Variations in shape of the two lateral masses of the atlas are possible. This might explain the apparent difference in alignment of the facet surfaces on the two sides in any one position of the head. Slight tilting of the dens as a congenital variant was seen in one patient by Dankmeijer and Rethmeier. This caused a wider interval between the dens and the articular mass of the atlas on one side than on the other. It seems more likely that in the majority of the cases a slight relaxation or redundancy of the supporting ligamentous structures is present allowing a certain amount of lateral "play" between the vertebrae. This was borne out in studies of several subjects who had shown considerable lateral motion in frontal roentgenograms. Lateral views were obtained with the head in neutral, maximum flexion and maximum extension. In some, but not in all, a definite widening of the space between the dens and the anterior arch of the atlas could be produced.

SUMMARY AND CONCLUSIONS

In anteroposterior roentgenograms of the upper cervical spine an apparent lateral shift of the atlas on the axis is frequently encountered. In a group of twenty-five normal individuals, nine showed some degree of lateral asymmetry between these two vertebrae. Investigation of other normal persons showed that in some a distinct lateral motion of the atlas on the axis could be demonstrated on lateral flexion of the head or by forceful pressure by an examiner

against muscular resistance on the part of the subject.

In the absence of other roentgenographic evidence, no diagnostic significance can be attached to such a finding.

Department of Radiology
University of Wisconsin Medical School
Madison, Wis.

REFERENCES

1. COURTS, M. B. Atlanto-epistropheal subluxations. *Arch. Surg.*, 1934, 29, 297-311.
2. DANKMEIJER, J., and RETHMEIER, B. J. Lateral movement in the atlanto-axial joints and its clinical significance. *Acta radiol.*, 1943, 24, 55-66.
3. JACOBS, L. G. Roentgenography of the second cervical vertebra by Ottonello's method. *Radiology*, 1938, 31, 412-413.
4. PANCOAST, H. K., PENDERGRASS, E. P., and SCHAEFFER, J. P. The Head and Neck in Roentgen Diagnosis. Charles C Thomas, Springfield, Illinois, 1942.
5. PLAUT, H. F. Fracture of the atlas in automobile accidents. *J.A.M.A.*, 1938, 110, 1892-1894.



PULMONARY ADENOMATOSIS WITH A NEW LABORATORY FINDING

By W. H. HATFIELD, M.D., and JOHN E. HILL, M.D.

*From the Division of Tuberculosis Control of British Columbia and the Department of Pathology
Vancouver General Hospital*

VANCOUVER, BRITISH COLUMBIA

THIS case of pulmonary adenomatosis is reported not only because the disease is rare and it is the first case reported in this area, but because from a search of the literature it is the first case where the clinical diagnosis has been definitely confirmed by a laboratory procedure.

In a review of the literature it is noted that cases have been reported from widely scattered geographical areas. As far as we know, this is the first case that has been reported in Canada.

REPORT OF CASE

A white housewife, aged fifty-four.

Previous Illness. Diphtheria, influenza, appendectomy.

Family History. Mother died of carcinoma. Father died of intestinal obstruction. Six brothers—two killed in war, others alive and well. Three sisters—one alive and well. One died of peritonitis. One died in childbirth.

Personal History. Patient was born in Manitoba. Never lived outside of Canada. Since 1936 she has lived on a dairy farm in the Fraser Valley in British Columbia. At no time has she had any contact with sheep.

Present Illness. Patient had been in good health until five years previously when she began to notice that she was becoming slightly dyspneic on climbing stairs. She paid little attention to this and the dyspnea changed very little until March, 1947, at which time she began to notice that she was tiring more easily and the dyspnea began to increase. However, it was noted that she did her own housework for a family of five and also kept up a vegetable garden for her family. In April, 1947, a roentgenologic survey was being conducted in her area and she attended with the community in general for an roentgen examination. The miniature film revealed roentgen changes and the patient was requested to report to a diagnostic clinic for further study. Figure 1 shows

the roentgenogram at that time. All clinical and laboratory findings were within normal limits. Tests made at that time were complete red and white blood counts, tuberculin test was doubtful, coccidioidin was negative, sputum tests for tubercle bacilli and fungus were negative.

By October, 1947, she had developed a cough and slight amount of sputum. Weakness and dyspnea became more marked. Examinations of the chest were all negative. Finally, in January, 1948, she was admitted to hospital with marked increase in her respiratory difficulty, cough, anorexia and beginning loss of weight. At no time did she complain of any pain.



FIG. 1. April, 1947.

Examination. Respiratory movements were accentuated and there were a few scattered moist rales. Examination of the heart was negative. There were no palpable masses and no enlarged glands. The nervous system was within normal limits. Skin was negative. Temperature remained within normal limits. Pulse varied from 80 to 150 per minute and respirations from 20 to 40 per minute. Red blood cells, 5,000,000 per cu. mm.; white blood cells, 12,600 per cu. mm.; differential normal. Hemoglobin

104 per cent. Non-protein nitrogen 41. Roentgen examination of the bone and joint structure was negative. Sputum examination was negative for tubercle bacilli. Roentgenograms of the chest as shown in Figure 2. During the investigations an attempt was made to aspirate one of the larger lesions in the right lung. It was found that despite the extensive pulmonary lesion seen in the roentgenogram, there was no obliteration of the right pleural space. A pneumo-

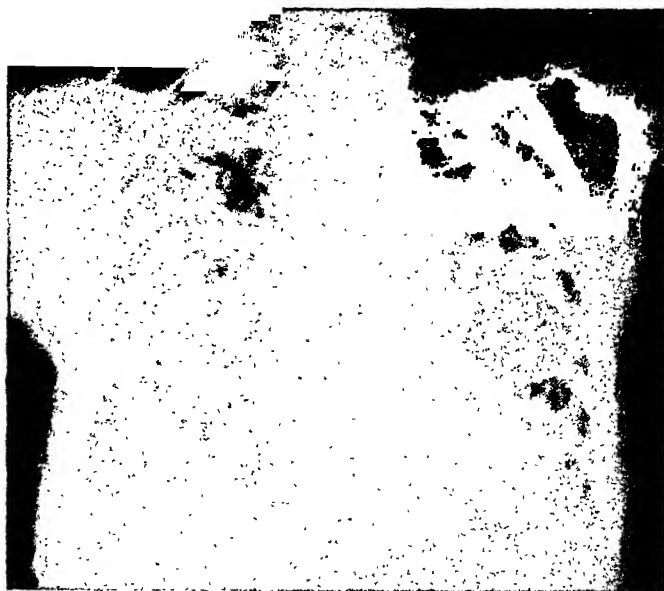


FIG. 2. January, 1948.

thorax was inadvertently produced and the procedure was abandoned. Roentgenograms taken after the pneumothorax showed equal collapse of the lung in all planes and no evidence of any pleural adhesions.

Differential Diagnosis. To reach a diagnosis on this case the following conditions were considered:

1. *Infections:* The case did not appear to fit into either acute or chronic infections. The acute it was felt were readily eliminated and the chronic infections, particularly tuberculosis, were eliminated from the roentgen appearance and the fact that with marked extension of disease the sputum was consistently negative for tubercle bacilli and at no time was there a fever.

2. *Inhalation and Aspiration Lesions:* These were eliminated by history.

3. *Carcinoma:* This did not have the appearance of a primary carcinoma of the lung and no primary lesions could be found elsewhere. Also, the patient continued to be well nourished until nearly the end of her illness and it was felt that carcinoma could be eliminated.

4. *Sarcoid:* This did not have the general appearance of sarcoid. The lesion tended to be progressively worse and at no time showed any clearing and did not appear to be typical in any way of sarcoidosis.

5. In general, lesions relative to the vascular system, the bronchi, and allergic phenomena and those related to the hemopoietic and metabolic functions could be ruled out.

6. *Pulmonary Adenomatosis:* By a process of exclusion it was felt that the most likely diagnosis in this patient was pulmonary adenomatosis so that a definite clinical diagnosis was made and the laboratory asked to search the sputum to see if anything could be found.

Considering the general pathological picture of pulmonary adenomatosis it would appear that with the extensive lesions which this patient had, some of the cells that grew out in the alveolar structures would break off and would be found in the sputum. The laboratory consistently found groups of cells in the sputum that were unusual. These are reproduced in Figure 3 in both high and low power. From the consistent findings of these groups of cells our pathologist made a specific diagnosis of pulmonary adenomatosis.

Progress of Case. This patient's lesion steadily progressed and her condition became steadily worse, no form of therapy being of any benefit. She eventually died on February 27, 1948.

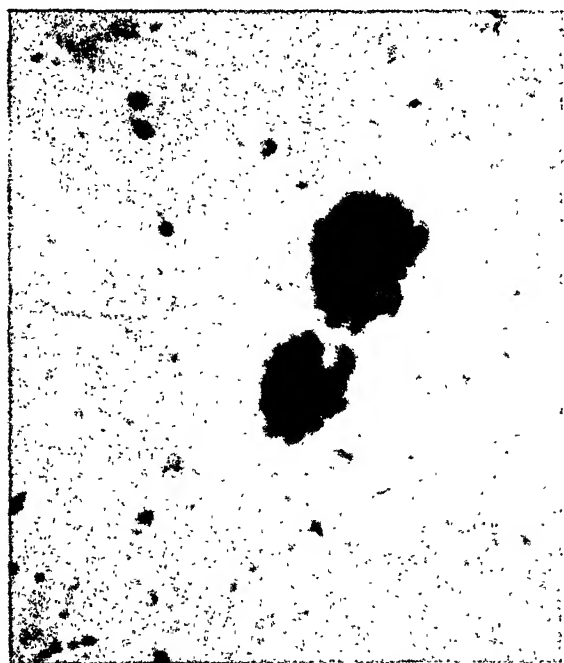
Pathological Report. Repeated examinations of sputa (Jan. 28, 30, 31, Feb. 3) revealed consistently regular findings. Smears from these specimens of sputum showed a number of small circumscribed round or oval masses of epithelial cells. The striking feature of these masses of cells was their very regular ovoid outline and the similarity in size and shape of such masses in the various specimens of sputum. The cells were fairly regular in size and shape; mitotic figures were not seen and the process appeared to be benign. With the finding of these polypoid epithelial masses in several specimens of sputum, it was concluded that the clinical diagnosis of pulmonary adenomatosis had been corroborated.

Autopsy Report (Four and a half hours after death). On opening the thoracic cage the sternum was removed with ease. The right pleural cavity contained a very small quantity of serous fluid and there were no adhesions between the parietal and visceral pleura. In the left

pleural cavity there were a number of fine, very easily separated adhesions between the parietal and visceral pleura. This pleural cavity contained only a small, normal quantity of pleural fluid.

Both lungs were in an expanded state and filled both pleural cavities. The lungs had a nodular feeling and could be compressed. The tracheobronchial tree was inspected and there were found a number of hard, shot-like, somewhat enlarged lymph nodes at the bifurcation of the trachea. The nodes were not definitely

there were no adhesions between the upper, middle and lower lobes. On sectioning the right lung, the cut surface presented a large number of whitish tumor masses varying from 2 mm. in diameter to more coalescent groups, the largest being approximately 4 cm. in diameter (Fig. 5). Between these white tumor masses could be seen reddish-brown, normal appearing pulmonary parenchyma. The replacement of pulmonary tissue by tumor had been so extreme that the brownish parenchyma appeared as threads between the masses. The masses were



A



B

FIG. 3. (A) 400X; (B) 900X.

matted together and could be separated singly without undue trouble. The cut surfaces of these nodes presented a whitish, firm peripheral portion, and an anthracotic center. About the hilum of both lungs similar enlarged, firm, shot-like nodes were found. The tracheobronchial tree was opened from behind and contained a quantity of moderately thick mucinous, bubbly sputum. This was not purulent, but appeared of a more glairy nature. The actual mucosa presented some injection but this was not a marked feature. Upon removal, the right lung remained in an expanded state and on its external surface it presented innumerable numbers of somewhat umbilicated nodules, of whitish color. These nodules were firm and between them was normal appearing pulmonary tissue (Fig. 4). The interlobar planes were clearly demarcated and

of a firm, rubbery consistency and did not retract below the cut surface. On pressure, a certain amount of milky exudate could be expressed from the nodules. On tracing the bronchi, the main stem and secondary bronchi were not remarkable. The tertiary bronchi could be traced and under the mucosa, bulging slightly into the lumina, could be seen a number of whitish raised areas. The left lung showed on its pleural surface a number of the thin strands of the previously mentioned fine pleural adhesions. The interlobar fissure was obliterated by adhesions. On sectioning the lung the cut surface presented an appearance exactly the same as that seen in the right lung. The bronchi were similar to that described on the right side. Each lung weighed 1,500 grams.

Microscopical Examination. Lungs: Smears

taken of the mucus found in the tracheobronchial tree showed numerous oval, circular cellular formations similar to those described as

was of a tall columnar type of epithelium. Sections of the pulmonary parenchyma (Fig. 6) demonstrated the general architecture to be

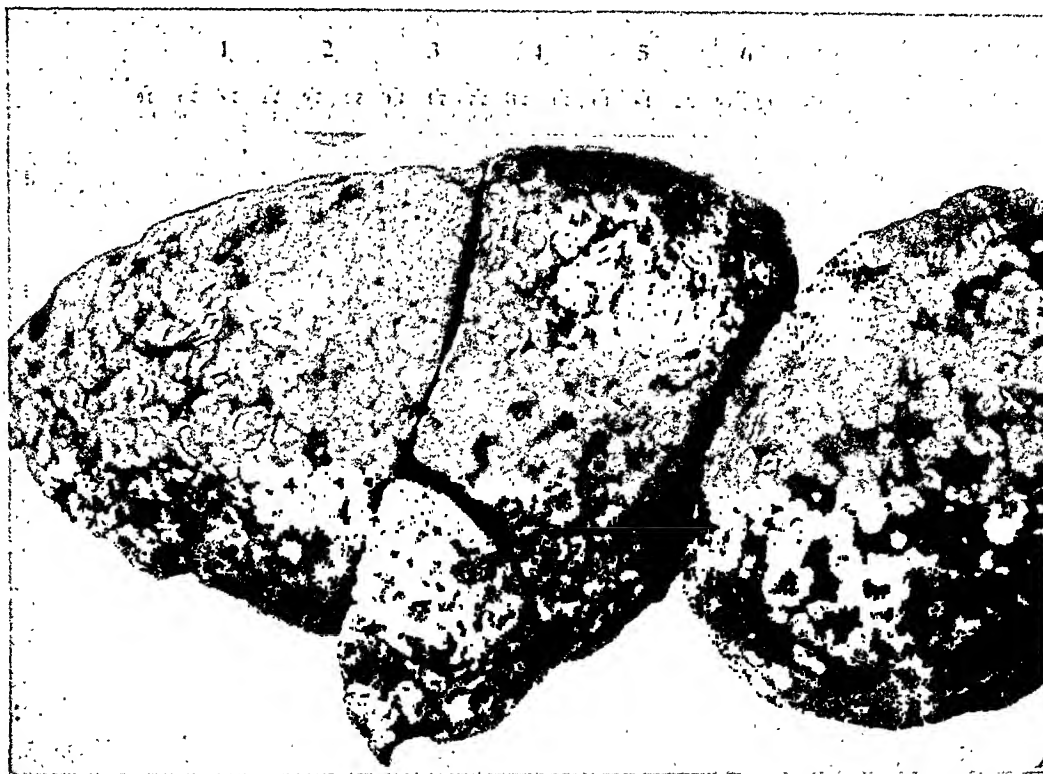


FIG. 4.



FIG. 5.

being found antemortem in the sputum. Sections taken through the bronchi and trachea showed no definite abnormality. The lining

maintained. The stroma was not altered. Between the tumor masses noted in the gross description were lines of normal appearing pul-

monary parenchyma. In the tumor structures (Fig. 7) the alveolar elements were made up of lines of cubocolumnar cells which were generally arranged in a single layer along the alveolar walls. These cells showed a pale translucent cytoplasm and regular vesicular nuclei placed in the basal section of the cells. There were no mitotic figures seen and the striking feature was the regularity of the cells. In many areas, the lining wall of the alveoli showed innumerable papillary infoldings. The microscopic picture of the affected alveoli was somewhat similar to that seen in the non-expanded fetal lung. In general, the affected alveoli tended to be grouped together, but scattered throughout the whole parenchyma were isolated alveoli which showed this same unusual cellular lining, while the surrounding alveoli presented an essentially normal appearance, other than for their lumina being filled with amorphous, pale staining coagulum. The terminal bronchioles could be recognized in the sections, and they showed a completely normal histological appearance. The whole picture appeared to be one of reversion to an early fetal type of alveolar epithelial, accompanied by polypoid proliferation. The histopathological picture was not one of malignant tumor.

Lymph Nodes: Sections taken through the hilar lymph nodes and those at the bifurcation of the trachea showed the normal lymphadenoid tissue to be in many instances nearly completely replaced by cellular elements arranged in alveolar forms, similar to those described in the lung. Sections taken through the lymph nodes in other areas than these showed an essentially normal histological picture.

The remainder of the postmortem revealed no evidence of any other metastatic lesions and no possible source of a primary carcinoma.

Conclusions. This case shows clinically a progressive replacement of pulmonary tissue with resultant death by asphyxia. Whether this replacement is of an inflammatory nature or a neoplastic nature or halfway between the two is almost impossible to say. Certainly the microscopic picture is not that of a malignant tumor, but the presence of deposits in the hilar lymph nodes is a strong point for malignancy. For lack of a better term, this might be called metastasizing pulmonary adenomatosis.

DISCUSSION

This disease has a pathological picture

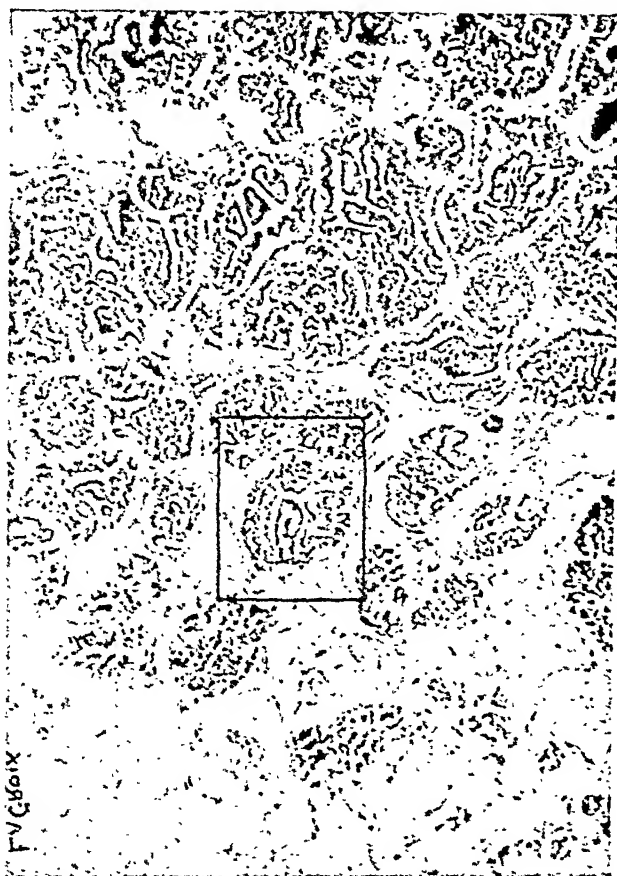


FIG. 6. 80X.

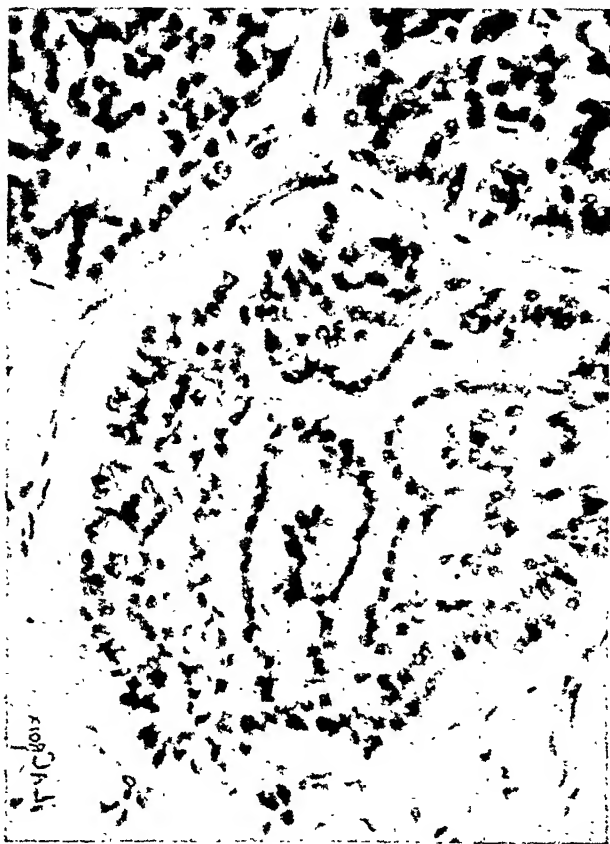


FIG. 7. 400X.

closely resembling a pulmonary lesion appearing in sheep which has received various names such as jaagsiekte, pulmonary adenomatosis, epizootic adenomatosis and infectious adenomatosis. A great deal has appeared in the veterinary literature and it has been presumed that the disease as it appears in sheep is of an infectious nature. Loehlein in 1903 found a picture resembling this condition in a sixty-nine year old woman. Similar cases have more recently been reported by Sims, Taft and Nickerson, Paul and Ritchie, and others.

Alveolar cell carcinoma of the lung usually presents some recognizable degree of malignant activity such as stromal invasion, mitotic figures, giant cell formation and more anaplasia than is seen in this case. If this is a case of alveolar cell carcinoma then it presents a microscopic picture that would be extremely difficult to diagnose as malignant except for the lymphatic metastases. Perhaps this condition is similar to those benign appearing adenomata of the thyroid gland which occasionally give rise to solitary metastases.

The disease as it appears in humans, however, is such that to date no satisfactory etiological basis has been determined. It is a hyperplasia of the pulmonary alveolar epithelium without the usual microscopic evidences of malignancy such as an invasion of the alveolar walls or mitotic figures, but which can metastasize.

The microscopic pictures of the pathological process in the lung of this patient clearly show the extensive papillary development within the alveoli, the intactness of the interalveolar structures and the lack of mitotic figures. It is apparent in examining these slides that there would logically be some breaking off of these cells to be extruded into the bronchi and brought up into the sputum. Consequently, one would expect that when the disease is present, particularly if it is fairly well advanced, the sputum examination should be

confirmatory of the diagnosis, such as has been shown in this case.

This case is of further interest in that this patient had an extensive pulmonary lesion and was carrying on a normal life and the lesion was only found in its relatively early stage in a mass community roentgenologic survey.

The course of the disease also demonstrates to what extent the pulmonary alveoli can be altered before clinical symptoms appear.

SUMMARY

1. A case of pulmonary adenomatosis is presented complete with clinical findings, course and postmortem report.
2. The pathology of the disease is discussed.
3. A method of recognizing the condition by the examination of the sputum is given.

Division of Tuberculosis Control
10th Ave. and Willow St.
Vancouver, B. C.

REFERENCES

1. BELL, E. T. Hyperplasia of the pulmonary alveolar epithelium in disease. *Am. J. Path.*, 1943, 19, 901-911.
2. GEEVER, E. F., NEUBUERGER, K. T., and DAVIS, C. L. The pulmonary alveolar lining under various pathologic conditions in man and animals. *Am. J. Path.*, 1943, 19, 913-937.
3. PAUL, L. W., and RITCHIE, G. Pulmonary adenomatosis. *Radiology*, 1946, 47, 334-343.
4. RICHARDSON, G. O. Adenomatosis of the human lung. *J. Path. & Bact.*, 1940, 51, 297-298.
5. SIMON, M. A. So-called pulmonary adenomatosis and "alveolar cell tumors"; report of a case. *Am. J. Path.*, 1947, 23, 413-426.
6. SIMS, J. L. Multiple bilateral pulmonary adenomatosis in man. *Arch. Int. Med.*, 1943, 71, 403-409.
7. TAFT, E. B., and NICKERSON, D. A. Pulmonary mucous epithelial hyperplasia (pulmonary adenomatosis); report of two cases. *Am. J. Path.*, 1944, 20, 395-411.
8. WOOD, D. A., and PIERSON, P. H. Pulmonary alveolar adenomatosis in man; is this the same disease as jaagsiekte in sheep? *Am. Rev. Tuberc.*, 1945, 51, 205-224.

MULTIPLE CHARCOT JOINTS*

By RAYMOND D. GOODMAN, M.D.

LOS ANGELES, CALIFORNIA

SINCE Jean Martin Charcot¹ described the neuropathic joint of tabes in 1868, there have been numerous case reports, theoretical discussions and critical analyses on all phases of this subject. The purpose of this paper is to present a most unusual case of multiple Charcot joints occurring in a male patient afflicted with tabetic neurosyphilis.

CASE REPORT

The patient, a white male, aged sixty-four was first admitted to the Los Angeles County

He stated he had a penile lesion in 1913. In 1926 a private physician told him he had a positive blood test for syphilis and gave him three courses of hip and arm injections. Just prior to this hospital entry another private physician had given him one course of hip and arm injections and one course of malaria fever therapy. The pertinent findings on physical examination revealed a positive Romberg test, Argyll-Robertson pupils and absent knee and ankle jerks. The blood and spinal fluid Wassermann tests were positive. No joint deformities were noted.

The patient was readmitted to the hospital in

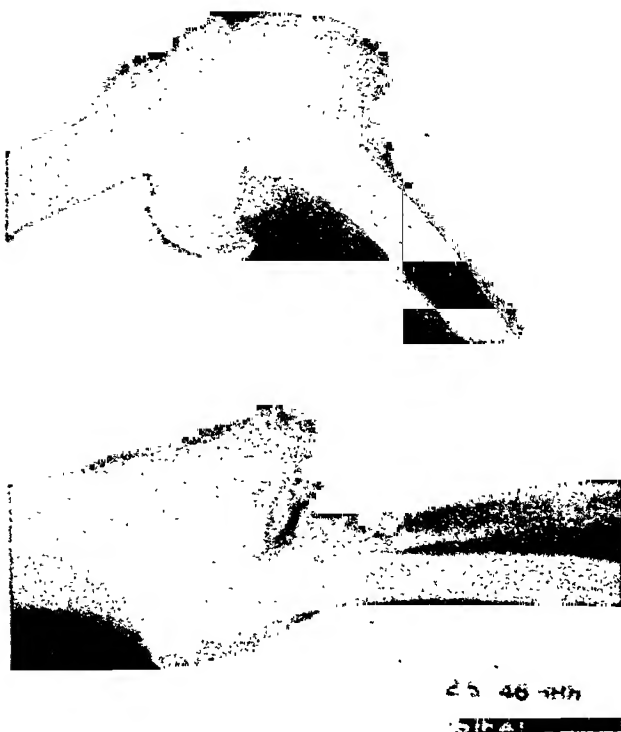


FIG. 1. Left elbow. Gross deformity consisting of severe hypertrophic bone changes with fragmentation, eburnation and dislocation.

Hospital in May, 1931. He was complaining of severe shooting pains in his lower extremities.

¹ Charcot, J. M. *Leçon sur les maladies nerveux*. Fourth Lesson. New Sydenham Series, 1868.

* From the Department of Medicine of the University of Southern California and the Los Angeles County Hospital.

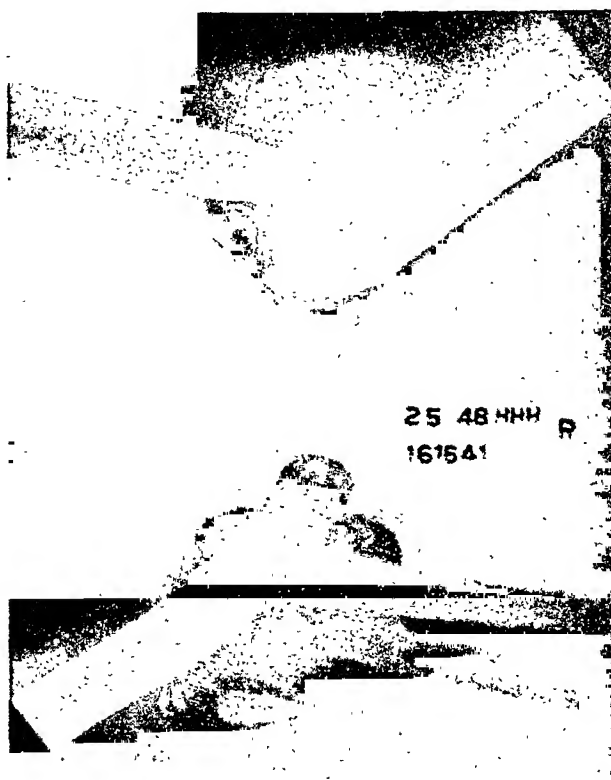


FIG. 2. Right elbow. Same as Figure 1.

December, 1937, because of swelling in his right elbow not related to trauma. Examination revealed the same neurological findings as noted before. The blood and spinal fluid Wassermann reactions were positive and there was a mid-zone colloidal gold curve in the spinal fluid. The



FIG. 3. Left knee. Hypertrophic arthritis with fragmentation. (Findings in right knee are similar and the roentgenogram is therefore not included.)



FIG. 4. Lumbar spine. Severe hypertrophic changes in all the lumbar vertebrae.

patient was referred to the Social Hygiene Clinic where he was started on intensive anti-luetic treatment. He was given a series of alternating courses of bismuth and mapharsen until 1942 at which time the blood Wassermann reaction was reported as negative.

In August, 1938, he complained of swelling in his left knee and on examination he was found to have an unstable knee with hyperextensibility. Roentgen examination revealed fragmentation at the anterior and medial distal ar-



FIG. 5. Lumbar spine, lateral view.

ticular margins with considerable eburnation of the adjacent bone. Marginal osteophytes at the patellar articular margins were also noted.

In April, 1940, he complained of weakness in his right knee and by July, 1940, he noted some swelling of that knee. In August, 1940, he was advised to wear a long leg appliance because both knees were unstable at that time.

In January, 1942, he was admitted to the urological service because of symptoms referable to a cord bladder. During a routine roentgen examination the third, fourth, and fifth lumbar vertebrae showed considerable sclerosis, deformity and osteophyte formation consistent with the diagnosis of a Charcot spine. The second lumbar vertebra appeared only slightly involved. The patient had no complaints referable to his back at that time.

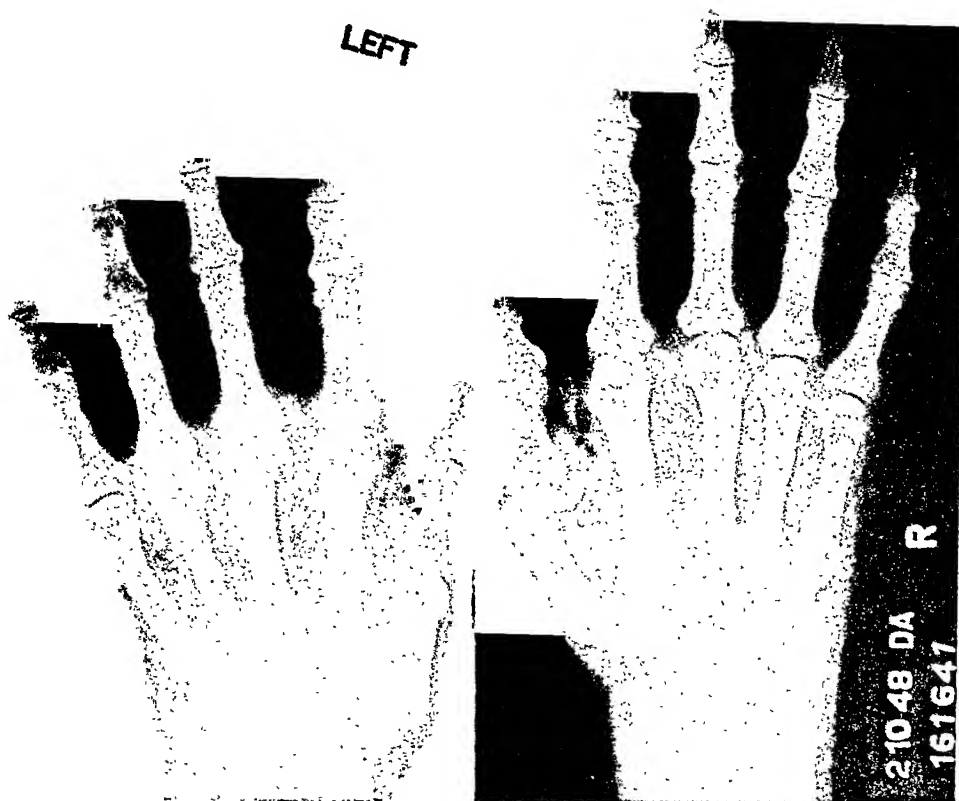


FIG. 6. Both hands. Left hand shows prominent bony hypertrophy of the distal portion of the metacarpals.

This patient was last seen on the medical service in February, 1948. He entered because of mild pains radiating up and down his arms and legs. Physical examination revealed the characteristic neurological findings of tabes dorsalis. A complete sensory examination excluded syringomyelia as a diagnostic probability. Both elbows and both knees revealed marked instability and hypermobility.

The important roentgen findings are shown in Figures 1, 2, 3, 4, 5 and 6. Roentgen findings in the pelvis, hips, shoulders, ankles and skull were not remarkable. A roentgenogram of the right foot showed an unusually abundant callus about an old fracture of the shaft of the fourth metatarsal.

Comment. At the present time the patient

is able to use a wheel chair and to some extent can walk on crutches. He is without pain. There is no evidence of trauma associated with these joint changes. The joint deformities have been progressive in spite of late antiluetic treatment.

SUMMARY

An unusual clinical picture of multiple neuropathic joints in a patient with tabetic neurosyphilis has been presented.

The assistance of Dr. R. A. Carter of the Department of Roentgenology is greatly appreciated.

1200 North State St.
Los Angeles, Calif.



ROENTGENOLOGIC FINDINGS IN OSTEOMYELITIS FOLLOWING BONE MARROW INFUSIONS IN INFANTS

REVIEW OF LITERATURE AND REPORT OF TWO CASES

By E. CLINTON TEXTER, M.D.,* W. A. IRWIN, M.D.,† and D. H. KAUMP, M.D.†

THE bone marrow has been of interest to investigators and hematologists for some years and recently the marrow space has assumed importance as a route for parenteral therapy. The value of intraosseous infusion in pediatrics has been noted;^{1,6} however, despite enthusiastic reports this route of medication has not received general acceptance.

Several reasons may account for this. In some instances, proficiency in the use of intravenous therapy may nullify the need for an alternate route. When intraosseous infusion is attempted by inexperienced personnel, a high incidence of failures and complications is likely to follow.

Of the possible complications there are two of serious nature. The first, mediastinitis, is fortunately rare, but it should be nonexistent.^{8,12} The cases which have occurred in infants or children have been due to the use of the sternum as a transfusion route in spite of the repeated admonition that the sternum should not be used below the age of three.

The second major complication is osteo-

myelitis. In our series of 383 intraosseous infusions we have had 2 cases of osteomyelitis, the reports of which follow:

CASE 1. This female infant, aged nineteen days, was admitted to the Pediatric Service on September 15, 1946, with a diagnosis of pyloric stenosis. During her period since birth she had only gained back to her birth weight of 6 lb. 2 oz. In addition to antispasmodics and appropriate feeding routines, 3,580 cc. of various solutions were given by intraosseous infusion. These solutions included 5 per cent dextrose in distilled water or in normal saline, whole blood, plasma and 5 per cent amigen. On two occasions these fluids were given as continuous infusions, once for twenty-four hours and once extending over a period of four days. At the end of the last continuous infusion, which did not run well, it was noted that the needle adaptor was cloudy. The needle was removed and approximately 20 cc. of purulent material was expressed from the soft tissues around the needle site. Penicillin (25,000 units) was injected locally, and parenteral penicillin was given at the rate of 50,000 units every two hours. A roentgenogram of the left tibia showed an osteitis involving the upper part of the

* From the Department of Pediatrics, Providence Hospital, Detroit, Michigan. At present Research Fellow in Medicine, Department of Medicine, Cornell University Medical College, New York, N.Y.

† From the Departments of Radiology and Pathology, Providence Hospital, Detroit, Michigan.

FIG. 1. Case 1. *A*, the roentgen study of October 8, 1946, demonstrates a defect in the lower part of the diaphysis of the left femur, indicative of a recent intraosseous blood transfusion. A similar defect with surrounding osteitis and periostitis is demonstrated in the upper end of the diaphysis of the left tibia, also indicating evidence of a recent intraosseous blood transfusion, and at this time suggesting evidence of early infection at the site of injection.

B, the studies of October 15, 1946, again demonstrate the defects in the upper end of the diaphysis of the left femur, which are slightly more prominent and typical of the usual findings following an intraosseous blood transfusion. The findings in the upper end of the left tibia show definite bone destruction at this time, indicating a rather well developed osteomyelitis.

C, the studies of October 29, 1946, show evidence of a healing osteomyelitis involving the upper part of the diaphysis of the left tibia, with good bone regeneration being well demonstrated at this time.

D, final studies of January 20, 1947, demonstrate the osteomyelitis involving the upper end of the diaphysis of the left tibia to be completely healed.

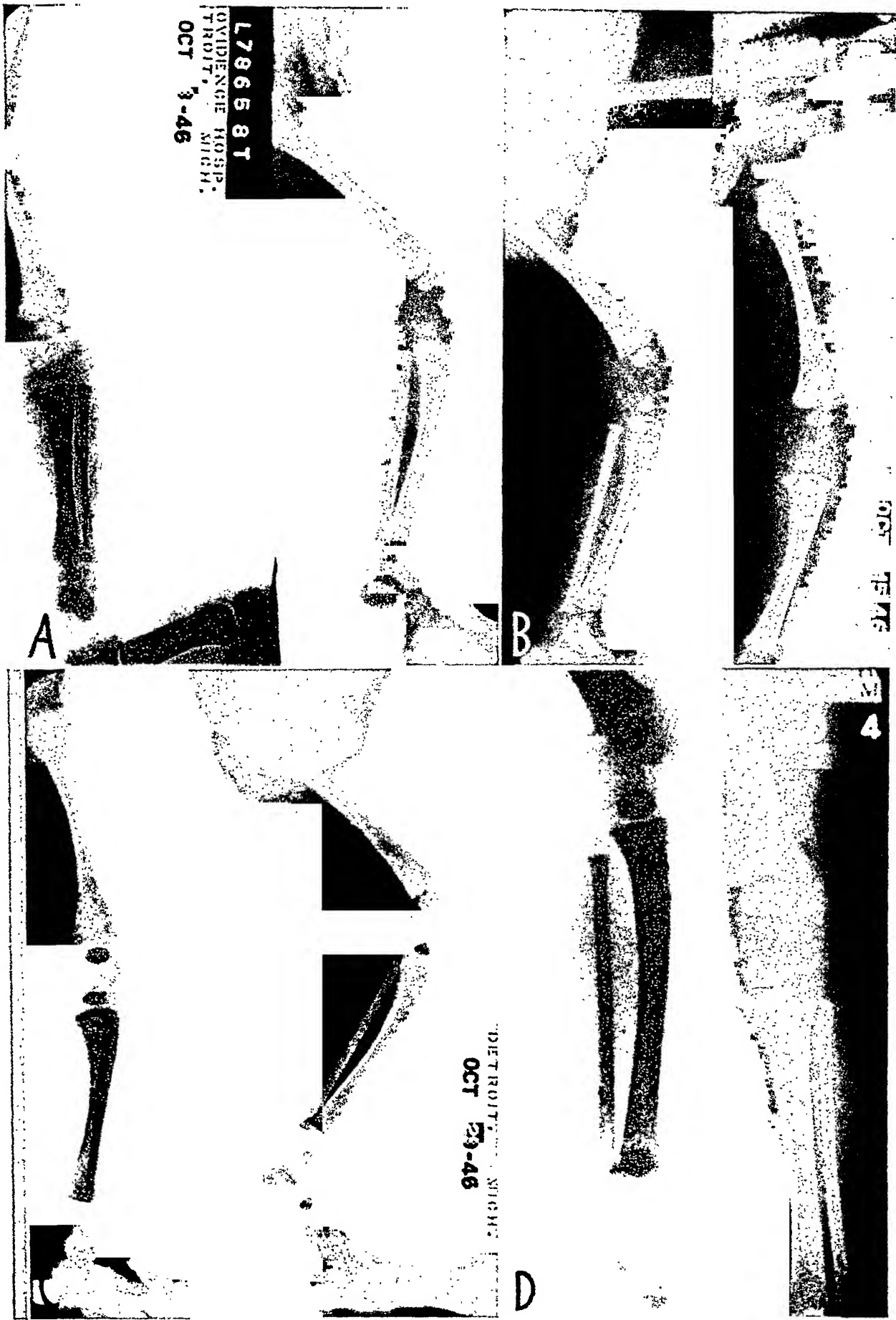




FIG. 2. Case II. *A*, the roentgen studies of March 31, 1947, demonstrate a small defect in the upper end of the right tibia indicative of a recent intraosseous blood transfusion. The bony structures are otherwise negative.

B, the studies of April 11, 1947, demonstrate evidence of a well developed osteomyelitis involving the upper end of the diaphysis of the right tibia, about the site of the previously described intraosseous blood transfusion.

C, the studies of May 2, 1947, demonstrate the osteomyelitis involving the upper end of the diaphysis

diaphysis of the left tibia, with a small sequestrum in this region (Fig. 1).

By October 14, 1946, it was decided that medical treatment would not control the pyloric stenosis and after giving 75 cc. of whole blood and 130 cc. of plasma into the right femur a Rammstedt pyloroplasty was done. Post-operatively 500 cc. of 5 per cent dextrose in distilled water was given through the needle in the right femur and penicillin was continued 50,000 units every two hours.

Roentgenograms at weekly intervals showed an osteomyelitis involving the upper 1.5 cm. of the diaphysis of the left tibia. Roentgenograms on October 29, 1946, showed a definite evidence of healing and by November 12 there was no evidence of activity. On November 15, 1946, the infant was discharged weighing 7 lb. 6 oz. Final roentgenographic studies on January 20, 1947, indicated complete healing of the osteomyelitis.

CASE II. This female infant, aged two months, was admitted to the Pediatric Service on March 24, 1947, with a history of diarrhea for three weeks. At the onset of the diarrhea, the weight was 9 pounds. She was given into the right tibia, by continuous drip, 500 cc. of glucose in saline, 500 cc. of 10 per cent glucose in distilled water, 100 cc. of parenamine and 100,000 units of penicillin. In the next five days the diarrhea rapidly subsided but at the end of this time there was generalized edema of the lower half of the body and depression of the fontanelles.

On her seventh hospital day a routine roentgenogram of the right upper tibia was taken (Fig. 2A). There was a defect in the upper part of the diaphysis indicating evidence of an intraosseous blood transfusion. No evidence of osteitis or periostitis was noted.

On the eleventh day she began to run a febrile course, and on the seventeenth day was very irritable. A raised, red, indurated area was noted on the right tibia at the site of the previous infusion. At this time a roentgenogram showed an osteomyelitis involving the

upper half inch of the diaphysis of the right tibia, with marked evidence of bone destruction (Fig. 2B). Grossly the upper third of the right leg had evidence of an acute infection and *E. coli* was obtained by culture. Penicillin (100,000 units) was given intramuscularly every two hours.

By the twentieth day her temperature was normal and the involved area was much improved. A roentgenogram on her twenty-fifth hospital day showed further bone destruction with increased periosteal reaction. On her thirtieth day 70 cc. of blood was given into the left tibia because of a moderate anemia. Subsequent roentgenographic studies showed no further evidence of bone destruction and on the thirty-ninth day there was evidence of a healing osteomyelitis (Fig. 2C). She was discharged on May 7, 1947, in good health weighing 9 lb. 11 oz.

A follow-up roentgenogram on June 10, 1947, indicated complete healing of the previously described osteomyelitis involving the upper end of the diaphysis of the right tibia (Fig. 2D).

In our review of the literature we have been able to find only 19 cases of osteomyelitis secondary to intraosseous infusion in infants. To these we add our 2 cases (Table 1).

It is probable that 2 of these cases should not have had infusions by this route. Case 7 was transfused through severely burned skin, and Case 8 had septicemia with multiple abscesses at the time of infusion. Ten of the 16 cases where data were complete were associated with the use of continuous infusions. In 4 instances, the infection developed following the use of hypertonic solutions (Cases 16-19), and both of our cases followed the use of protein hydrolysates.

Heinild *et al.*⁵ believed that both the use of hypertonic solutions and continuous infusion played a major role in the patho-

of the right tibia which is healing well, and excellent bone regeneration is demonstrated, along with some new periosteal bone formation. No evidence of any spread of the process since the earlier studies can be noted.

D, a final examination on June 10, 1947, demonstrates a complete healing of the osteomyelitis involving the upper part of the diaphysis of the right tibia. The site of the osteomyelitis is now indicated only by a slight sclerosis of the bone in that region.

TABLE I
SUMMARY OF REPORTED CASES

Case No.	Author	No. of Infusions Reported	Diagnosis	Sex	Age	Location of Osteomyelitic Organisms	Method of Infusion	Solutions Used	Roentgen Findings	Treatment	Results Sequelae
1	Behr	60+	—	—	—	Tibia	Cont. ?	—	—	Surgical	Complete healing
2	Rooney	250	Diarrhea	—	1 mo.	Femur, lt. hemolytic streptococcus and <i>Staph. aureus</i>	Cont. 3 hours	Blood—50 cc. Saline—75 cc.	Extensive destruction of distal third of diaphysis, periosteal proliferation	Surgical incision local and oral sulfathiazole	Complete healing in 7 weeks, no residual
3	Rooney	250	Diarrhea	—	3 mo.	Tibia, lt.	Cont. ? hours	Blood—80 cc. Saline—250 cc.	No evidence of bone destruction	Surgical incision local and oral sulfathiazole	Complete healing in 7 weeks, no residual
4	Reisman and Tainsky	?	Erythroblastosis fetalis premature	—	New-born	Femur, lt.	Direct	Blood—60 cc.	Periosteal thickening, distal fourth of femoral diaphysis	Surgical incision, local use of 5% Na sulfathiazole and 1:10,000 zephiran Cl.	Complete healing, no residual
5	Tocantins, Price and O'Neill	79	—	—	—	—	—	—	—	—	—
6	Tocantins, Price and O'Neill	79	—	—	—	—	—	—	—	—	—
7	Levy	?	Severe burn	—	—	Tibia	—	—	—	—	—
8	Stokes	?	Septicemia, multiple abscesses, anemia	—	2 mo.	Tibia, rt.	—	Blood	—	—	—
9	Gunz and Dean	35	—	—	—	—	Direct	Saline	—	—	Complete healing ?
10	Gunz and Dean	35	Empyema	—	18 mo.	Tibia?	Cont. 12 hours	Blood	—	Surgery	Complete healing ?
11	Gunz and Dean	35	Erythroblastosis fetalis	—	11 mo.	Tibia ?	Cont.	Blood	—	Surgery	Complete healing ?
12	Quilligan and Turkel	45	Congenital duodenal obstruction	—	New-born	Tibia, 45	Cont. 4 days	—	—	None	Died with duodenal obstruction, generalized peritonitis, osteomyelitis of entire rt. hip.

13	Quilligan and Turkel	—	—	—	—	—	—	—	—	—	—	—
14	Walsh and Zadek	—	Acute appendicitis with diffuse peritonitis	F	3 yr.	Tibia, lt.	Cont. ?	Glucose in saline, plasma, blood, penicillin	Osteomyelitis with rarefaction within $\frac{1}{2}$ inch of upper epiphyseal plate	Incision, later saucerization, penicillin	Complete healing, no residual	
15	Heinild <i>et al.</i>	982	Diarrhea	—	2 wk.	Tibia, lt.	Cont. 32 hours	Serum—220 cc. Saline—50 cc.	Rarefaction in proximal metaphysis	Saucerization	Complete healing 2 mo. At 14 mo. 1 cm. shortening of left leg	
16	Heinild <i>et al.</i>	982	Premature infant with eczema	—	Premature	Tibia, rt.	Direct	Concentrated serum—20 cc.	Extensive osteomyelitis with large osseous abscess in metaphysis, total necrosis of entire diaphysis, enveloped by vigorous sequestral capsule	Surgical	Complete healing 1 mo. Died in 5 mo. of intercurrent infection	
17	Heinild <i>et al.</i>	982	Diarrhea	—	10 wk.	Tibia, lt.	Direct	50% glucose in saline—10 cc.	Progressive osteomyelitis, extensive destruction proximal metaphysis, vigorous periosteal formation around diaphysis	Penicillin	Healing with 1 cm. shortening at 6 mo. X-ray epiphyseal line almost effaced, zone of ossification irregular, metaphysis broadened	
18	Heinild <i>et al.</i>	982	Diarrhea	M	6 wk.	Tibia, lt.	Direct	50% glucose—20 cc.	Typical osteomyelitis, extensive destruction of proximal metaphysis, periosteal reaction of entire metaphysis	Penicillin	Complete healing at 8 mo. X-ray slightly irregular epiphyseal line	
19	Heinild <i>et al.</i>	982	Diarrhea	F	1 wk.	Tibia, lt.	Direct	50% glucose—10 cc.	Extensive osteomyelitis, focal destruction of proximal metaphysis, area of rarefaction in distal metaphysis, total necrosis of entire diaphysis with vigorous sequestrum	Sulfathiazole	Complete healing. Died intercurrent infection 1 mo. later	

genesis of osteomyelitis following intraosseous infusion, for in their series all 5 cases of osteomyelitis were associated with the use of continuous infusion or hypertonic solutions. They found the risk of osteomyelitis following the use of continuous infusion or hypertonic solutions to be 13 per cent. However, in our series¹¹ only 2 of 33 infants who received continuous infusion developed osteomyelitis, an incidence of 6 per cent.

The over-all risk of osteomyelitis is difficult to ascertain. However, if the three largest series of infusions reported are totaled, some idea of its calculated risk can be obtained.

TABLE II

Author	No. of Infusions	Cases of Osteomyelitis
Meola ⁶	326	0
Texter and Kaump ¹¹	383	2
Heinild <i>et al.</i> ⁵	982	5
	1691	7

Percentage of osteomyelitis—0.41 per cent

SUMMARY

We have presented the clinical and roentgenologic findings in two cases of osteomyelitis secondary to intraosseous infusion and in addition have summarized the other nineteen cases reported to date.

The over-all risk of osteomyelitis in this procedure is low (0.41 per cent) unless hypertonic solutions or continuous infusion is used when the risk becomes much greater (6-13 per cent).

Intraosseous infusions are further contraindicated in the presence of severe skin or generalized blood stream infections.

In none of these cases reported did the infection prove fatal, and in all cases com-

plete healing occurred without residual change.

W. A. Irwin, M.D.
Providence Hospital
Detroit, Mich.

REFERENCES

1. ARBEITER, H. I., and GREENGARD, J. Tibial bone marrow infusions in infancy. *J. Pediat.*, 1944, 25, 1-12.
2. BEHR, G. Bone-marrow infusions for infants. *Lancet*, 1944, 2, 472-473.
3. ELSTON, J. T., JAYNES, R. V., KAUMP, D. H., and IRWIN, W. A. Intraosseous infusions in infants. *Am. J. Clin. Path.*, 1947, 17, 143-150.
4. GUNZ, F. W., and DEAN, R. F. A. Tibial bone-marrow infusions in infants. *Brit. M. J.*, 1945, 1, 220-221.
5. HEINILD, S., SØNDERGAARD, T., and TUDVAD, F. Bone-marrow infusion in childhood; experiences from 1,000 infusions. *J. Pediat.*, 1947, 30, 400-412.
6. MEOLA, F. Bone-marrow infusions as a routine procedure in children. *J. Pediat.*, 1944, 25, 13-16.
7. QUILLIGAN, J. J. JR., and TURKEL, H. Bone marrow infusion and its complications. *Am. J. Dis. Child.*, 1946, 71, 457-465.
8. RAVITCH, M. M. Suppurative anterior mediastinitis in an infant following intrasternal blood transfusion; operation and recovery. *Arch. Surg.*, 1943, 47, 250-257.
9. REISMAN, H. A., and TAINSKY, I. A. The bone marrow as an alternate route for transfusion in pediatrics. *Am. J. Dis. Child.*, 1944, 68, 253-256.
10. ROONEY, E. F. Bone marrow infusion with two cases of localized osteomyelitis. *Arch. Pediat.*, 1944, 61, 611-616.
11. TEXTER, E. C., and KAUMP, D. H. Intraosseous infusions in infants. *J. Michigan State Med. Soc.*, 1948, 47, 1002-1006.
12. TOCANTINS, L. M., and O'NEILL, J. F. Complications of intra-osseous therapy. *Ann. Surg.*, 1945, 122, 266-277.
13. TOCANTINS, L. M., PRICE, A. H., and O'NEILL, J. F. Infusions via the bone marrow in children. *Pennsylvania M. J.*, 1943, 46, 1267-1273.
14. WALSH, A. R., and ZADEK, I. Reaction in tibia following intramedullary administration of fluids. *J. Pediat.*, 1947, 30, 324-326.



CHANGES IN THE COAGULABILITY OF THE BLOOD AFTER RADIATION THERAPY

THE RESULTS OF STUDIES USING THE MODIFIED WAUGH-RUDDICK TEST FOR INCREASED COAGULABILITY*

By SEYMOUR B. SILVERMAN, M.D.†

DURHAM, NORTH CAROLINA

THE need for a test to detect finer changes in the clotting process, especially when an increased coagulability is present, was met by Waugh and Ruddick,³⁷ who put the clotting mechanism into "slow motion" through the use of heparin. By this means, any change in the clotting time is magnified and easily measured. A modification of the original test has recently been described,³⁴ which further increases the ease and accuracy with which blood coagulation studies can be made.

Having previously studied the effect of operation on the coagulability of the blood,³⁴ it was decided to apply the modified test to an investigation into the effect of irradiation on the coagulation process.

REVIEW OF THE LITERATURE

There is no agreement among workers in this field as to the effects of irradiation on blood coagulation. This is due to numerous factors, including the use of different coagulation tests, differences in the amount and intensity of radiation employed, as well as different time-intervals between the application of radiant energy and the performance of the coagulation test. Some of these causes of disagreement will be discussed below.

Following exposure of the spleen to irradiation, a decreased coagulation time was reported by Stephan,³⁵ Jurasz,¹⁴ Osgood,¹⁹ and most recently by Ostro and Macht.²⁰ This was variously attributed to an increased function of the splenic pulp,³⁵ and a disintegration of lymphocytes in the splenic follicles with liberation of thrombo-

plastic substances.³⁵ Other workers report similar results following irradiation of areas other than the spleen,^{3,5,11,21-25,31,40} and explain the change as being due to the liberation of a "blood coagulation accelerating" cytozyme from disintegrated leukocytes and platelets;¹¹ to an increase in platelets, prothrombin and fibrinogen;³¹ to an undetermined direct action on the blood itself;²¹⁻²⁴ and to an acceleration of the transformation of prothrombin to thrombin.⁴⁰

On the other hand, a decreased coagulability of the blood following irradiation has been reported by Lacassagne *et al.*,¹⁷ Fabricius-Möller,⁹ Bernhard,³ Pfahler,²⁶ Zunz and La Barre,⁴⁰ Reding,²⁹ Kaufmann,¹⁵ Allen and co-workers,^{1,2} and Rekers and Field.³⁰ Among the factors said to be involved here are a decrease in blood platelets,^{9,17} a prothrombin deficiency,¹⁵ and the production of an anticoagulant substance resembling heparin.^{1,2} Reding,²⁹ studying the coagulation time of recalcified plasma following irradiation, found a decreased coagulability in 80 per cent of 15 cancerous patients irradiated for the first time. Four patients who had received four to six series of radiation treatments all showed a decreased coagulability of the blood.

Of the various factors involved in the clotting process, the platelets (i.e. thromboplastin) and fibrinogen have received the most study as regards the effect of irradiation. Portis²⁷ found the platelets unchanged in a series of roentgen-ray workers. A large dose of radiation is said to cause a

* From the Department of Pathology, Division of Surgical Pathology and Haematology, McGill University, Montreal. Aided by grant from the Hutchison Fund, Faculty of Medicine, McGill University.

† Formerly Medical Research Fellow of the National Research Council, Canada. Now at Duke Hospital, Durham, North Carolina.

fall in platelets, while a small dose occasions a rise in their number.^{4,6,7,10,18,32,33,39} A rise in blood fibrinogen following irradiation has been reported by Saelhof,³¹ Stephan,³⁵ and others (ref. 12, 13 and 16, cited in Dunlap⁸).

OUTLINE OF THE MODIFIED TEST

In a previous communication,³⁴ details of a proposed modification of the Waugh-Ruddick test are set forth. Therefore, only a brief outline of the test need be presented at this time.

Increasing concentrations of heparin are made in physiological saline, so that 0.1 cc. of saline contains 1/50, 2/50, 3/50 up to 7/50 units of heparin. Seven small test tubes (13 by 100 mm.) containing saline, heparin and calcium chloride are set up as shown in Table I. Four and one-half cubic

TABLE I
CONTENTS OF THE TEST TUBES BEFORE THE
ADDITION OF PLASMA

Tube	0.9 Per Cent NaCl Containing Heparin	0.01 M Calcium Chloride
1	0.1 cc. 1/50 unit	0.2 cc.
2	0.1 2/50	0.2
3	0.1 3/50	0.2
4	0.1 4/50	0.2
5	0.1 5/50	0.2
6	0.1 6/50	0.2
7	0.1 7/50	0.2

centimeters of blood are drawn by venipuncture and are mixed immediately and thoroughly with 0.5 cc. of 0.1 M sodium oxalate. The blood is centrifuged at 1,000 r.p.m. for five minutes, during which time the seven prepared tubes are placed in a water-bath at 37.5° C. Following centrifugalization, the plasma is removed, and 0.1 cc. is added to each tube. The tubes are corked, agitated gently to insure mixing of the fluid and plasma, and replaced in the water-bath. The time is recorded, and the test begins. Starting after about two and one-half minutes, the first tube is partially removed from the rack and tilted slightly

to determine whether coagulation has taken place. If this has not occurred, the tube is gently replaced, and is examined every half minute until clotting has occurred. The time is recorded. This procedure is carried on for each successive tube, and the results are plotted, coagulation time against concentration of heparin.

REPORT OF CASES

Ten patients, receiving radiation therapy at the Royal Victoria Hospital for various neoplastic conditions, were followed at regular intervals during their treatment, and blood coagulability curves were done after the modified method of Waugh and Ruddick. Each patient received approximately 300 r per day, and the blood was taken one to two hours after treatment. The physical factors involved in giving the radiation were 200 kilovolts at 50 cm. focus-skin distance. For filtration, 1.0 to 2.0 mm. of copper was used. Of the 10 cases studied, only 4 need be described, as these are typical of the whole series.

CASE I. Miss M., aged forty-five, was admitted for treatment of carcinoma of the cervix uteri. She received 300 r a day, delivered through two anterior and two posterior fields, so that the entire pelvis was under bombardment. In total, 5,000-6,000 r was delivered to each side. Figure 1 shows some of the curves obtained on this patient. There is a counter-clockwise shift of the curves, indicating decreased coagulability of the blood. The values opposite each curve represent the total irradiation (in roentgens) received at the time of the test. Curves obtained after 5,700 r had been given went off the graph, and are not shown.

CASE II. Mr. G., aged sixty, entered the hospital for treatment of a lymphoepithelioma of the left tonsil. On admission, there was local extension as well as spread to the left side of the neck. Treatment was therefore concentrated on this side, and a total of 9,000 r (300 r daily) was given. The right side received 5,000 r, both to treat any clinically uninvolved areas on that side as well as to cross-fire the left side. Three fields were employed on each side, covering the neck, nasopharynx and the base of the skull. In Figure 2 are shown some of the coagulability

curves obtained from this patient. Here again, a decreased coagulability of the blood is present, indicated by a counter-clockwise shift of the curves with increasing total dosage in roent-

made, and the patient received 14,000 r, through four fields, to the local area. Figure 3 shows the behavior of this patient's blood coagulability. The counter-clockwise rotation of

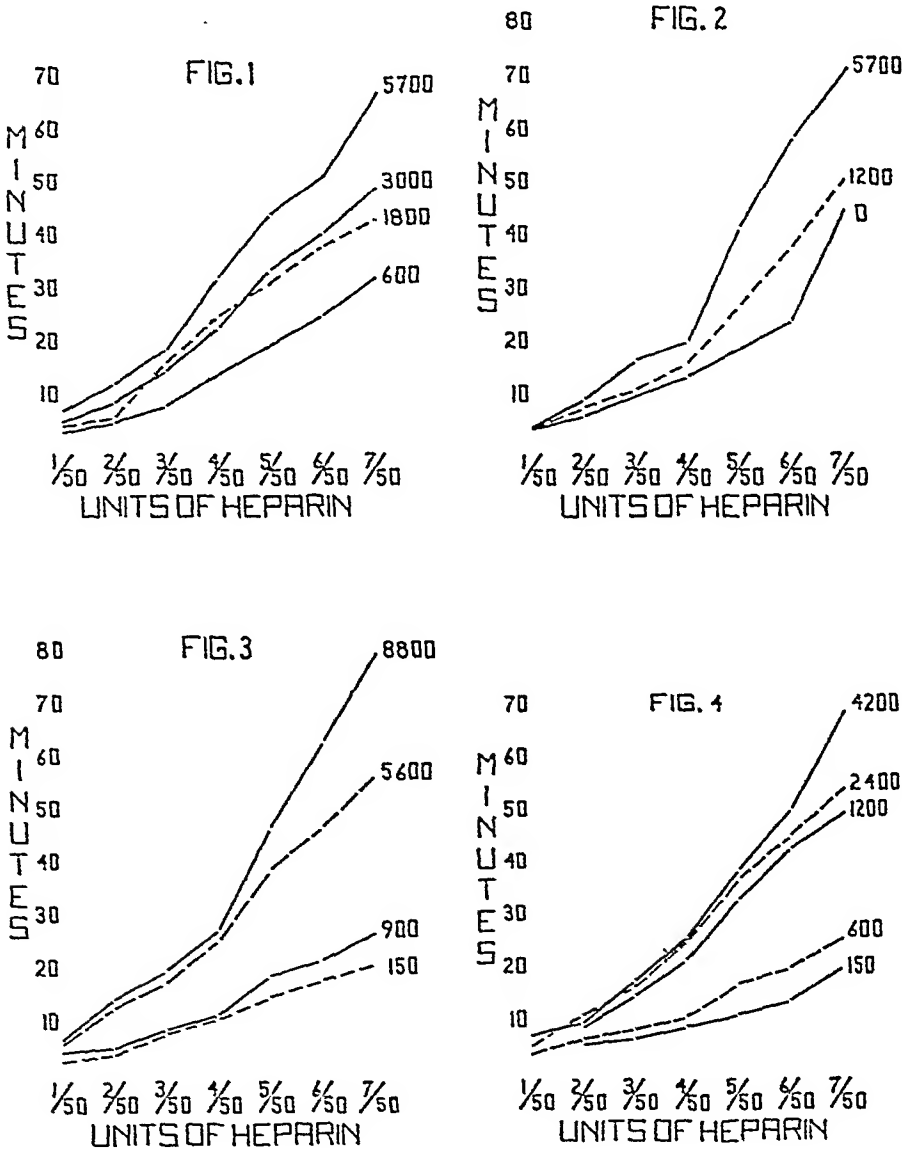


FIG. 1. (The values opposite each curve represent the total irradiation, in roentgens, received at the time of each test; only those tests are shown whose coagulation curves remained entirely on the graph.) Case I. Cancer of the cervix. Total irradiation approximately 12,000 r. Note the counter-clockwise shift of the curves, indicating decreased coagulability of the blood.

FIG. 2. Case II. Lymphoepithelioma of the tonsil. Total irradiation 14,000 r. Decreased coagulability is present, indicated by an anti-clockwise shift of the curves.

FIG. 3. Case III. Osteogenic sarcoma of the leg. Total irradiation 14,000 r. The decreased coagulability appears to be proportional to the total irradiation received at any point during the course of therapy.

FIG. 4. Case IV. Cancer of the cervix. Total irradiation 12,000 r. Note the counter-clockwise shift of the curves, as well as the relation between the height of the curve and the amount of radiation given.

gens. No curves obtained with the total radiation dosage above 5,700 r are shown, for these went off the graph.

CASE III. Miss D., aged seventeen, was admitted complaining of a painful mass in the left leg. A diagnosis of osteogenic sarcoma was

the curves is present, and the decreased coagulability appears to be proportional to the total radiation received at any point during the course of therapy. In this case, the curves did not go off the graph until more than 8,800 r had been given.

CASE IV. Mrs. V., aged fifty-six, received a total of 12,000 r to the pelvis for cancer of the cervix. The anti-clockwise shift of the coagulability curves, and the fact that this shift is roughly proportional to the total radiation dose, are well shown in Figure 4. Above 4,200 r, the curves went off the graph.

DISCUSSION

From the above it is evident that the coagulability of the blood is decreased by irradiation, at least in the doses used in treating neoplastic disease. In 2 of the patients studied, there was a primary increased coagulability when the total dose of radiation was 600 r or lower. However, above this point, all exhibited a decreased coagulability. This is in keeping with the fact that a stimulus may be irritative at one intensity and depressive at another. It also explains, to some degree, the varied results reported in the literature. Those investigators reporting an increased blood coagulability following irradiation for the most part used small doses of radiant energy.^{21-24,40} Those reporting a decreased coagulability employed large doses of radiation.^{9,17,29,40} Dunlap⁸ states that the most important single factor determining the degree of the blood changes and the rate at which they develop is the dose of radiation absorbed by the patient. The greater the dose, the more profound is the blood damage, the more rapidly it develops, and the more slowly it is repaired. There are also individual variations in radiosensitivity which are increased by differences in age or health.

It is stated⁸ that the same dose of radiation gives a different degree of blood damage, depending on what part of the body is exposed. Irradiation of the abdomen is found to produce greater changes in the blood than treatment over the chest, head or extremities. These regional differences in the effectiveness of irradiation are greater than can be explained by any differences in the amount of blood or of hemopoietic tissue included in the various fields of treatment. In this series, differences in

degree were present, but a decreased coagulability of the blood was obtained regardless of the area stimulated.

A source of confusion has always been the progressive nature of the blood changes following irradiation. Observations made today may be in conflict with tomorrow's findings. Obviously, the complete picture of the coagulability changes can only be obtained by repeated determinations at short intervals during the course of therapy, such as was done in this series.

Accurate measurement of the coagulation time, while highly desirable, is not always easy, due to the many external factors which may affect the process. These include changes in temperature, foreign bodies in the test tubes, air bubbles in the syringe, etc. The Waugh-Ruddick test and its modification, by measuring the coagulation time under controlled conditions, in tubes containing increasing amounts of heparin, allow of seven or eight determinations being made, and even if the reading of a single tube does not fit into the general contour of the curve of the graph, it can be discarded without preventing one from determining whether any abnormality exists.

The decreased coagulability of the blood seen after heavy irradiation is, according to various workers, due to a reduction in plasma prothrombin secondary to liver damage,¹⁵ a reduction in platelets (and thus thromboplastin) due to bone marrow damage,^{9,17} and the production of an anticoagulant substance.^{1,2} While very little work was done in this series to investigate the cause of the coagulability change, certain remarks in this direction can be made. About thirty prothrombin time determinations were done, using both rabbit brain and Russel viper venom as the source of thromboplastin. In most of the cases, the time was within normal limits. While it is true that severe liver damage will cause a fall in prothrombin, it is also a fact that the percentage of plasma prothrombin has to fall to around 35 per cent of normal before the clotting time is pro-

longed to the extent seen in the above series. It is difficult to see how irradiation of such distant sites as the tonsil and leg could produce sufficient liver damage to reduce that organ's prothrombin production by two-thirds.

Quick²⁸ states that thromboplastin is the trigger-substance of the coagulation process, and that it initiates and determines the speed of the reaction. A reduction in the thromboplastin factor, either in the plasma or in the platelets, would therefore occasion an increased clotting time. Waugh and Ruddick³⁸ reduced the platelet count in plasma samples by centrifugalization, and obtained a counter-clockwise shift of the coagulability curves, indicating a prolongation of the coagulation time, similar to that seen following irradiation. Inasmuch as these investigators feel that their test is a measure of available thromboplastin, the findings after irradiation would suggest a reduction in this factor.

Very recently, Allen and his group^{1,2} have described an irradiation syndrome in dogs dying as the result of roentgen-ray exposure of 450 roentgens over the entire body. The clotting and bleeding times were markedly prolonged after the sixth day, and the blood failed to clot after the ninth day even through thromboplastin, fibrinogen, prothrombin and calcium were present. The clotting property was restored to normal by the addition of protamine sulphate or toluidine blue, both of which bind and biologically inactivate heparin. Allen *et al.* isolated an amorphous material possessing high anticoagulant properties which seemed "in no way dissimilar from a standard sodium heparin salt." In summary, they felt that the prolonged clotting and bleeding times were due to "the presence in the circulation of an anticoagulant whose properties, as far as tested, were indistinguishable from those of heparin." It will be interesting to learn whether similar conclusions can be drawn from a study of the blood of patients receiving therapeutic doses of radiation. One would hesitate to unreservedly apply the findings obtained

in dogs subjected to lethal doses of roentgen rays.

SUMMARY

Using the modified Waugh-Ruddick test, studies of blood coagulation were done on a series of patients receiving radiation therapy for neoplastic disease.

The coagulability was found to be decreased, and this trend was roughly proportional to the total irradiation received.

The possible causes of this change are reviewed.

I wish to make grateful acknowledgment to Dr. T. R. Waugh for his advice and assistance during the course of this work, and in the preparation of the manuscript.

Box 3531
Duke Hospital
Durham, N. C.

REFERENCES

1. ALLEN, J. G., and JACOBSON, L. O. Hyperheparinemia; cause of the hemorrhagic syndrome associated with total body exposure to ionizing radiation. *Science*, 1947, 105, 388-389.
2. ALLEN, J. B., SANDERSON, M., MILHAM, M., KIRSCHOW, A., and JACOBSON, L. O. Heparinemia (?). *J. Exper. Med.*, 1948, 87, 71.
3. BERNHARD, F. Röntgenreizbestrahlung der Milzgegend und Blutgerinnung. *Arch. f. klin. Chir.*, 1924, 130, 193.
4. BUCKY, G., and GUGGENHEIMER, H. Steigerung der Knochenmarksfunktion durch Röntgenreizdosen. *Klin. Wchschr.*, 1922, 1, 11.
5. CANUET, G., and WOLFE, M. Action de l'irradiation de divers territoires sur les hemorrhagies nasales. *Compt. rend. Soc. de biol.*, 1924, 91, 611.
6. CRAMER, W., DREW, A. H., and MOTTRAM, J. C. On blood platelets; their behaviour in "vitamin A" deficiency and after "irradiation" and their relation to bacterial infections. *Proc. Roy. Soc. Lond.*, 1922, 93, 449.
7. DUKE, W. W. Variation in the platelet count; its cause and clinical significance. *J.A.M.A.*, 1915, 65, 1600.
8. DUNLAP, C. E. Effects of radiation on the blood and the hemopoietic tissues, including the spleen, the thymus and the lymph nodes. *Arch. Path.*, 1942, 34, 562-608.
9. FABRICIUS-MÖLLER, J. Etudes expérimentales sur la diathèse hémorrhagique déterminée par les rayons roentgen. *Compt. rend. Soc. de biol.*, 1922, 87, 759.

10. FALCONER, E. H., MORRIS, L. M., and RUGGLES, H. E. Effects of x-rays on bone marrow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 342-351.
11. FEISSLY, R. Beiträge zur Blutgerinnungsbeschleunigung mittels Röntgenstrahlen. *München. med. Wchnschr.*, 1921, 68, 1418.
12. FRISCH, A., and STARLINGER, W. *Ztschr. f. d. ges. exper. Med.*, 1921, 24, 142.
13. HELD, A., and HÜLBACH, H. Der Fibrinogenspiegel des Blutes unter dem Einfluss von Röntgenbestrahlung und die primäre Strahlenwirkung. *Strahlentherapie*, 1934, 51, 664-671.
14. JURASZ, A. T. Zur Frage der therapeutischen und prophylaktischen Blutstillung in der Chirurgie. *Zentralbl. f. Chir.*, 1920, 47, 824.
15. KAUFMANN, J. The coagulogram as a critical indicator of irradiation effect. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 55, 464-472.
16. KNIPPING, H. W., and KOWITZ, H. L. Ueber die Einwirkung der Röntgenstrahlen auf die Eiweisskörper des Plasmas. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1923-1924, 31, 660-664.
17. LACASSAGNE, A., LAVEDAN, J., and DE LEBARDY, J. Syndrome purpurique provoqué par les rayons X chez le lapin nouveauté. *Compt. rend. Soc. de biol.*, 1922, 86, 668.
18. MOTTRAM, J. C. Some effects of exposure to radium on the blood platelets. *Proc. Roy. Soc. Med.*, 1922 (Sect. Path.), 16, 9.
19. OSGOOD, E. E. Action of benzol, roentgen-rays and radium on blood and blood-forming organs. *Ann. Int. Med.*, 1932, 6, 771-774.
20. OSTRO, M., and MACHT, D. I. Pharmacological and radiological study of hemophilia. *South. M. J.*, 1946, 39, 860-867.
21. PAGNIEZ, P., RAVINA, A., and SOLOMON, I. Influence de l'irradiation de la rate sur le temps de coagulation du sang. *Compt. rend. Soc. de biol.*, 1922, 87, 349.
22. PAGNIEZ, P., RAVINA, A., and SOLOMON, I. Recherches sur la coagulabilité du sang après irradiation in vitro. *Compt. rend. Soc. de biol.*, 1922, 87, 1170.
23. PAGNIEZ, P., RAVINA, A., and SOLOMON, I. Rayons X et coagulation sanguine. *Presse méd.*, 1924, 32, 545.
24. PAGNIEZ, P., RAVINA, A., and SOLOMON, I. Action de l'irradiation de divers territoires sur la coagulabilité du sang. *Compt. rend. Soc. de biol.*, 1924, 90, 1227.
25. PETERSON, W. F., and SAELHOF, C. C. Selective organ stimulation by roentgen rays; enzyme mobilization. *AM. J. ROENTGENOL.*, 1921, 8, 175-178.
26. PFAHLER, G. E. Effects of x-rays and radium on the blood and general health of radiologists. *AM. J. ROENTGENOL.*, 1922, 9, 647.
27. PORTIS, M. M. Blood changes in workers with roentgen rays, and apparatus for protection. *J.A.M.A.*, 1915, 65, 20.
28. QUICK, A. J. Coagulation of the blood; theoretical and practical aspects. *Proc. Inst. Med. Chicago.*, 1946, 16, 94-106.
29. REDING, R. Variations du temps de coagulation sous l'action des rayons X. *Compt. rend. Soc. de biol.*, 1935, 119, 342-344.
30. REKERS, P. E., and FIELD, J. B. Control of hemorrhagic syndrome and reduction in x-radiation mortality with a flavanone. *Science*, 1948, 107, 16.
31. SAELHOF, C. C. Influence of x-ray organ stimulation on the coagulation mechanism. *AM. J. ROENTGENOL.*, 1921, 8, 179-182.
32. SELLING, L., and OSGOOD, E. E. In: Downey, H., Editor. *Handbook of Hematology*. Paul B. Hoeber, Inc., New York, 1938, Vol. 4, p. 2689.
33. SHOUSE, S. S., WARREN, S. L., and WHIPPLE, G. H. Aplasia of marrow and fatal intoxication in dogs produced by roentgen radiation of all bones. *J. Exper. Med.*, 1931, 53, 421-435.
34. SILVERMAN, S. B. Modification of Waugh-Ruddick test for increased coagulability of the blood, and its application to the study of postoperative cases. *Blood*, 1948, 3, 147.
35. STEPHAN, R. Retikulo-endothelialer Zellapparat und Blutgerinnung. *München. med. Wchnschr.*, 1920, 67, 309.
36. SZENES, A. Drüsenbestrahlung und Blutgerinnung. *München. med. Wchnschr.*, 1920, 67, 786.
37. WAUGH, T. R., and RUDDICK, D. W. Test for increased coagulability of the blood. *Canad. M.A.J.*, 1944, 50, 547-549.
38. WAUGH, T. R., and RUDDICK, D. W. Studies on increased coagulability of the blood. *Canad. M.A.J.*, 1944, 51, 11-17.
39. WRIGHT, S., and BULMAN, H. A. Selective action of x-rays on the blood cells of the cat. *Lancet*, 1929, 2, 217-219.
40. ZUNZ, E., and LA BARRE, J. Variations de la coagulabilité, de la glycémie et de la calcémie sous l'influence des rayons X. *Compt. rend. Soc. de biol.*, 1927, 96, 125.



EFFECT OF ATROPINE ON ACUTE IRRADIATION SICKNESS IN MICE*

By JOHN C. LARKIN, M.D.

Department of Radiology, New Britain General Hospital

NEW BRITAIN, CONNECTICUT

THE theory that the effect of ionizing radiation is due to liberated histamine-like substances has been advocated. It has also been suggested that the new antihistamine drugs should alleviate this effect. Seven of the antihistamine drugs† were injected into mice, and a slightly greater tolerance to radiation was noted. The antihistamine drugs also have a weak atropine action³ and in order to determine whether the protection was due to the weak atropine action or the antihistamine action of these drugs, atropine alone was injected. A greater percentage of the mice survived when atropine alone was used than when the antihistamine drugs were used. The slight protection given by the antihistamine drugs is apparently due to their weak atropine action.

PROCEDURE

Albino Swiss female mice were obtained from Carworth C F₁ strain throughout the past year. They varied from 18 to 22 grams in weight. In order to equalize this variation in weight, since the larger mice have greater tolerance to radiation, the mice were divided between control and irradiated groups according to weight.⁴ The mice were kept in a constant temperature animal room and fed the usual "dog chow" diet. No supplementary vitamins were added to the diet.

The mice were irradiated in groups of 10 in a circular chamber covered with cellophane. The backscattering from the table top was approximately 10 per cent. A 200 kv., 20 ma. General Electric therapy unit was used. A 1 mm. Al filter was added to the inherent filter of the oil-cooled tube.

† Benadryl, pyribenzamine, antistine, transetine, thephorin, Nu-1326, Nu-1525.

The distance from target to chamber was 30 cm. Under these conditions the output was quite high and averaged 192 roentgens per minute. The high irradiation rate accounts for the lower survival rate than is at times given in the literature.² A Victoreen 100 r chamber checked against a 3.33 mg. radium needle was used as a standard throughout the year. The atropinized and control mice were always exposed the same day, and under identical conditions. Care was taken to prevent crowding in the irradiation cage.

The mice were injected intramuscularly by using 0.1 cc. of a 0.45×10^{-3} M. solution of atropine sulfate in normal saline. The outside of the thigh was used for the injections. This site seemed to produce the least damage to the mice. These few mice which died a few minutes after a reinjection were not considered in the statistics as they undoubtedly were killed by the trauma of the injection. The injections were given daily beginning twenty-four hours before irradiation and continued until the fifteenth day. No variation of this dose was used. The weights were kept, and the loss of weight was quite uniform in the control group, but a much smaller percentage of the treated mice lost weight. The typical signs of acute irradiation sickness were observed in all control mice. There was a decrease in their fluid and solid intake, they soon lost their sleek appearance, and a few days before dying were so weak and emaciated they were unable to feed themselves. In the treated groups the symptoms were not noted so early. However, mice which showed no evidence of severe irradiation sickness on one day, were often found dead on the following day.

* This work was supported by the Connecticut Cancer Society.

RESULTS

In order to demonstrate statistically the atropine effect on irradiated mice they were considered to survive if they were still alive on the eighteenth day. This was three days after medication was stopped, and all pharmacological action of atropine dissipated. By the eighteenth day almost all the irradiated mice which had received a lethal dose died. The treated mice died as late as the thirty-fifth day, and a greater

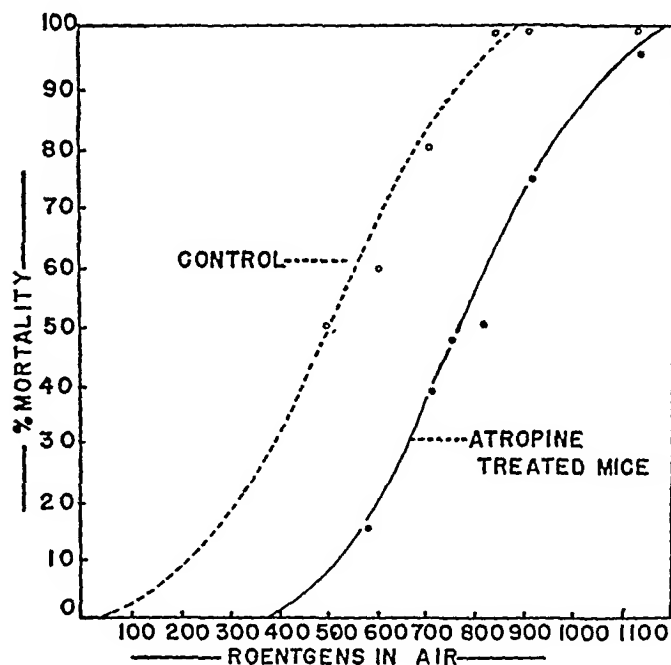


FIG. 1. Survival curves on eighteenth day. There is 250 r difference between the curves of the control and atropinized mice.

percentage of them died after the eighteenth day when the drug was discontinued. It is not known whether they would have lived had the drug been continued after the eighteenth day.

The results of the 104 control mice are shown in Figure 1, broken line. The curve is the typical "S" probability curve, and agrees quite well with the usual survival curves for mice found in the literature.¹ At approximately 600 r 60 per cent of the controls were dead by the eighteenth day. As the groups received larger amounts of radiation fewer survived. The three groups receiving more than 740 r all died.

The mice receiving a daily dose of atropine also received more radiation, which

they must tolerate if the drug is to be effective. There were 106 mice in this group. In spite of the definite protection given to a majority of the mice it had no effect in a small percentage, and these treated mice died as early as the controls. However, in the central portions of the survival curves (Fig. 1) where lethal doses are given, and where there is not so much radiation given that the effect of the atropine is no longer present, there is an unquestionable difference in the mortality of control and treated mice. When the radiation exceeded 910 r the treated groups failed to survive.

The average survival time for the groups receiving absolute lethal amounts of radiation (1,152 r) is shown in Figure 2. Forty-four mice in the control group lived five days and only 1 more than eleven days. In the treated group the average was twelve days and 1 animal survived more than thirty-five days. Thus even when lethal

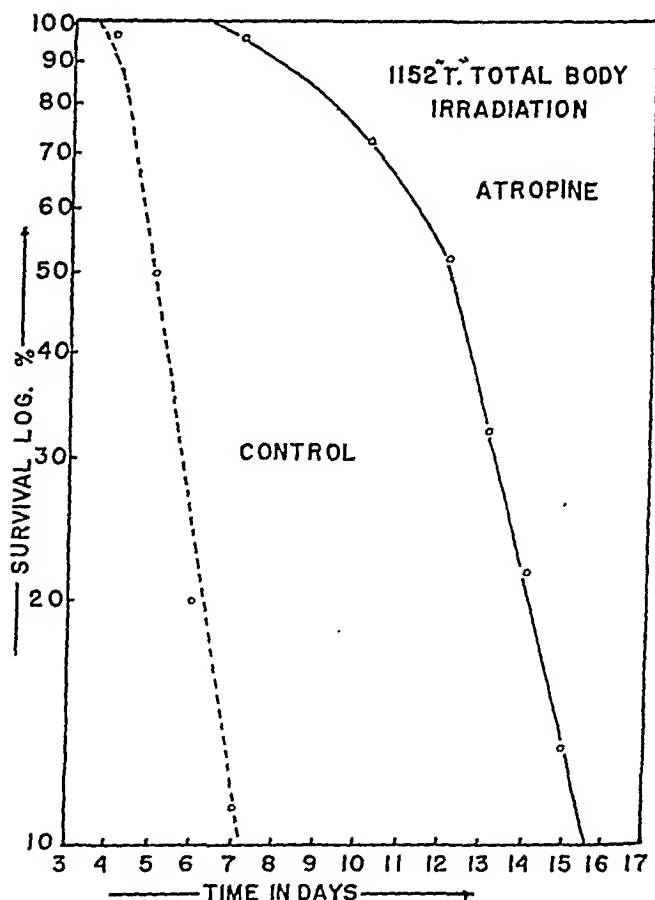


FIG. 2. The atropinized mice average survival time was twelve days, while the control group averaged five days. A single mouse survived 1,152 r.

doses were given, the survival time was almost twice that of the controls, and atropine produced an effect on irradiation sickness.

COMMENT

The finding that the autonomic blocking agent, atropine, will affect irradiation sickness suggests another ionizing radiation reaction. Atropine competes with acetylcholine, and overcomes its pharmacological action by preventing acetylcholine from entering effector cells. When the atropine increases the resistance of the mice to radiation it may be affecting the function of almost any organ, so the protecting mechanism is not known.

SUMMARY AND CONCLUSIONS

1. Atropine in dosages of 0.1 cc. of a $0.45 \times 10^{-3}M$. solution when injected daily has an effect on the survival of mice receiving roentgen radiation.

2. The increase in survival rate is shown to be greater than would be expected by chance. It is necessary to give 250 r more to the treated mice to produce the same per cent mortality as the controls.

3. When 1,152 r was given neither the treated nor control mice survived. However

the average survival time for the control group was five days while the treated mice lived twelve days. Thus even when an absolute lethal dose was given atropine still has an effect.

4. Atropine given at other time intervals or a different dose was not investigated. None of the other autonomic blocking agents were tried.

5. Ionizing radiation must produce multiple injurious reactions. The particular reaction that atropine produces is not the most important, as the protection is incomplete.

New Britain General Hospital
New Britain, Conn.

REFERENCES

1. ELLINGER, F. Lethal dose studies with x-rays. *Radiology*, 1945, 44, 125-142.
2. HENSHAW, P. S., RILEY, E. F., and STAPLETON, G. E. Plutonium project; biologic effect of pile radiations. *Radiology*, 1947, 49, 349-359.
3. LOEW, E. R., MACMILLAN, R., and KAISER, MARGARET E. Antihistamine properties of benadryl, β -dimethylaminoethyl benzhydryl ether hydrochloride. *J. Pharmacol. & Exper. Therap.*, 1946, 86, 229-238.
4. QUASTLER, H. Studies on roentgen death in mice; body weight and sensitivity. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 457-461.



THE TIME FACTOR IN LETHAL EFFECTS OF TOTAL ROENTGEN IRRADIATION IN TRITON

By V. V. BRUNST and E. A. SHEREMETIEVA-BRUNST

University of Maryland, School of Medicine

BALTIMORE, MARYLAND

THE problem of dose distribution in time is one of the most important problems in the field of radiotherapy. There are in roentgen therapy two conflicting opinions. According to one of them the so-called "time factor" plays a significant role in the final results of irradiation (Holthusen,¹ Zuppinger,² Regaud and Fer-

biology to determine which of these two concepts is correct. This problem can be clarified only by large and numerous experiments involving not one but many species and extending the observations to all the observable effects on all the life processes that it is possible to investigate.

The purpose of the present investigation

TABLE I

Experimental Group	I	II	III	IV
Duration of treatment period (in days)	23	23	22	I
Number of treatments	20	20	4	I
Dose given during every treatment (in r)	150	150	750	3000
Target-object distance (in cm.)	25	112	25	25
Duration of every treatment	5.1 min.	102.3 min.	25.5 min.	102 min.
Summarized time of treatment	1 hr., 42 min.	34 hr., 6 min.	1 hr., 42 min.	1 hr., 42 min.

TABLE II

Experimental group	I	II	III	IV
Duration of treatment period (in days)	23	23	22	I
Number of treatments	20	20	4	I
Dose given during every treatment (in r)	100	100	500	2000
Target-object distance (in cm.)	25	112	25	25
Duration of every treatment	3.4 min.	68.2 min.	17 min.	68 min.
Summarized time of treatment	1 hr., 8 min.	22 hr., 44 min.	1 hr., 8 min.	1 hr., 8 min.

roux,³ Jüngling and Langendorff,⁴ Zwerg,⁵ Sax,⁶ Motida and Adati,⁷ Bauer,⁸ Lea,⁹ Ellinger,¹⁰ Lasnitzki,¹¹ Hueper and de Carvajal-Forero,¹² Lavedan,¹³ Sax,¹⁴ and others). The Coutard method of protracted fractionated roentgen therapy as well as Frankfort's and other similar methods are based on the acknowledgment of the importance of the time factor. The adherents of the second opinion ascribe very little or no significance to the dose rate factor (Abele,¹⁵ Herčik and Machek,¹⁶ Langendorff,¹⁷ Fano and Demerec,¹⁸ and others).

It is the task of experimental roentgen

was to study the effect of total body irradiation of adult tritons (*Triton cristatus*, Amphibia, Urodela) with a definite dose of roentgen radiation differentially distributed with respect to time.

The conditions of the irradiation were as follows: 120 kv. max., 3 ma., filter 3 mm. Al. The target-object distance varied in different experiments (see Tables I and II). During the time of the irradiation the treated group of animals (20 or 22 specimens) was placed in a wooden box (15 by 15 by 3 cm.) which was covered with gauze to keep the animals inside. The bottom of the box was

covered with wet cotton to prevent the drying of the animals. Two series of experiments were performed. Each series involved four experimental groups and one control group.

Each group of the first series consisted of 20 animals. All treated animals were given 3,000 r. These experiments were started on June 13. The dosages, time intervals and other factors of the roentgen treatments in these experiments are given in Table I.

effect with the dosage given. Furthermore, it is a well known fact that in the laboratory the Amphibia are extremely sensitive to all external factors and are especially affected by high temperatures. In these experiments performed during the summer months such high temperatures were observed. These early deaths of these most sensitive animals in groups I and II were probably related to the combined effect of high temperatures aggravated by the dis-

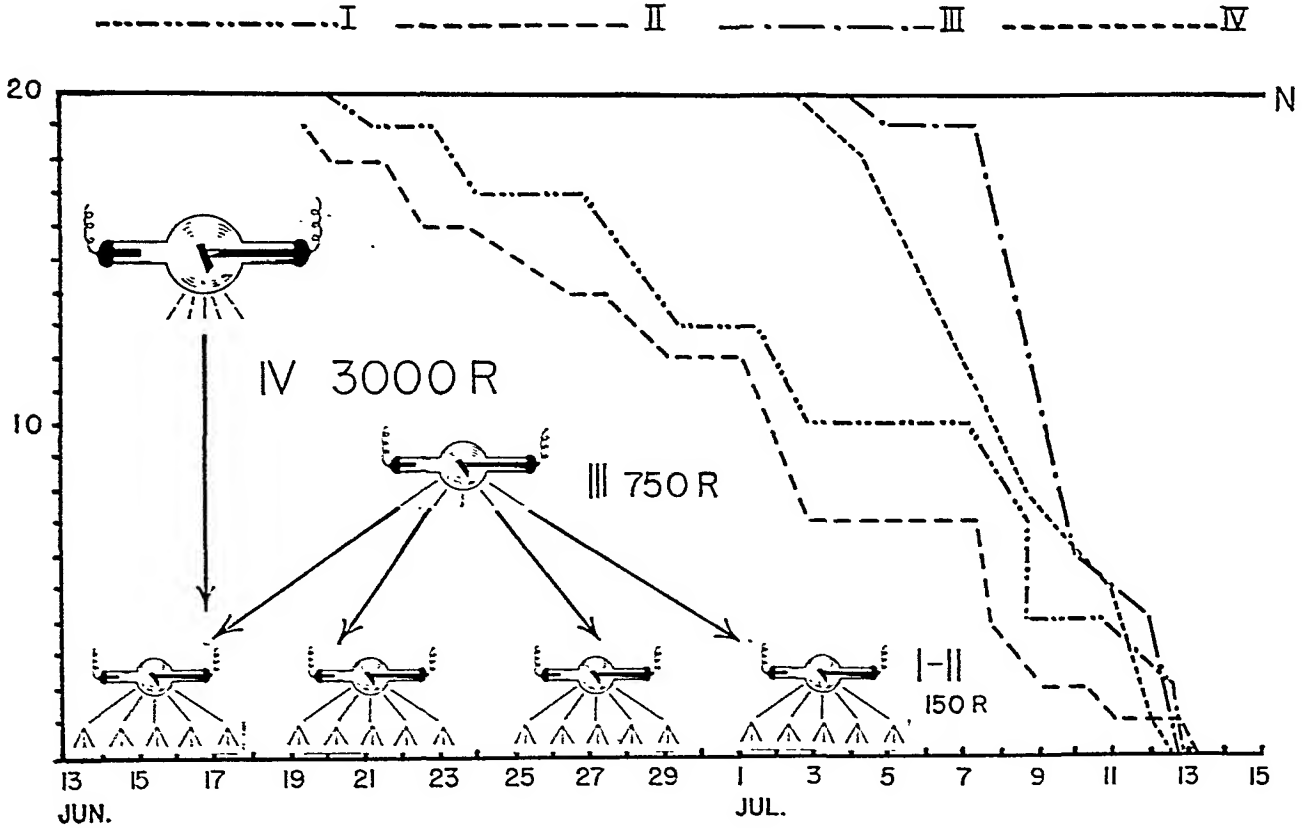


FIG. 1. The results of the first series of experiments. Ordinates: number of animals. Abscissas: period of observation. The roentgen tubes symbolize the time of the irradiations. Continuous line (N) refers to the control animal group. Differently dotted lines refer to the treated animal groups.

The results of this series of experiments are shown in Figure 1. The animals in groups I and II began to die gradually after a few daily doses had been given. It was thought that their death was caused not only by the roentgen treatment but appeared to be influenced by other factors, as the dose applied during this time was probably not large enough to cause their death in such a short time interval. It is also improbable that this short interval was long enough to be a latent period for a lethal

turbance of the daily exposure to the heated roentgen tube and the superimposed effect of the comparatively small doses of roentgen radiation. All the animals of groups I and II died within an interval of twenty-five days, while the death of the animals in the other two groups, III and IV, occurred during a nine to eleven day period. The results of these experiments show that the length of the maximum survival period was the same for all four groups. It may be observed from Figure 1 that while animals of

groups I and II began to die earlier and more gradually, all the animals of the four treated groups died within thirty days after the first irradiation. None of the control animals died during this period. Obviously the dose of 3,000 r administered under the existing conditions was a dose large enough to shorten the life of the treated tritons to one month.

The second series of experiments, as was

animals of groups I and IV died relatively early in the experiment. The animals began to die in numbers approximately one month and a half after the beginning of the irradiation, and they continued to die for approximately three weeks until all the animals had succumbed. As observed in the first series, near the end of the experiment the death of a number of the remaining animals of all four experimental groups oc-

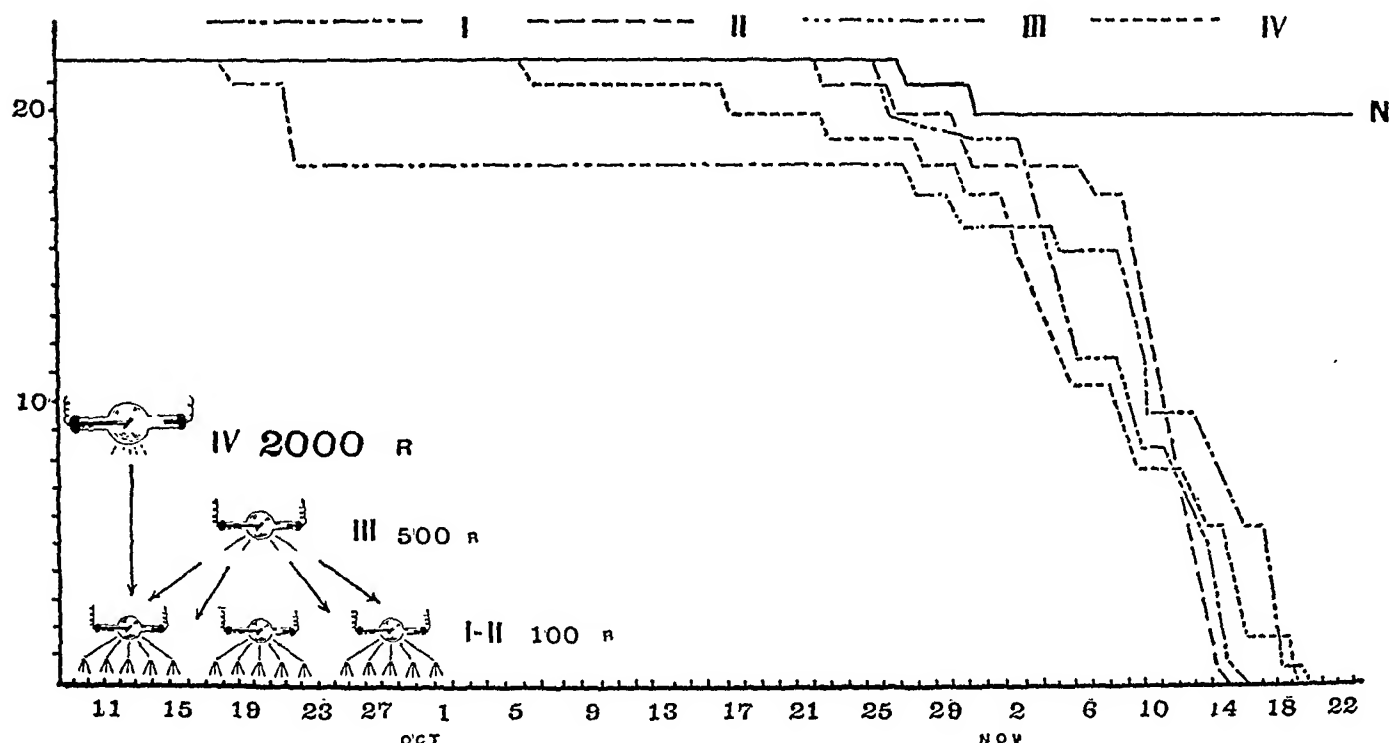


FIG. 2. The results of the second series of experiments. The key see Figure 1. In this figure only fifteen treatments are shown for groups I and II. The animals in these groups actually received twenty radiation treatments as indicated in Table II. The five irradiation periods had to be omitted from this chart in order to conform to twenty days on the time scale.

said above, involved also four experimental groups and one control group. All treated animals were given 2,000 r. Each group consisted of 22 animals. These irradiation experiments were started on September 9. The dosages, time intervals and other factors of the radiation treatments in these experiments, are given in Table II.

A comparison of the reactions of the animals of both series revealed that the animals in this second experiment responded more uniformly and harmoniously to the dose of 2,000 r even though this was administered in varying amounts and at different time intervals. Only a few

occurred at about the same time. Only two control animals died during the experimental period.

On the basis of these results the following conclusion may be drawn: The dose of 2,000 r caused the death of all treated tritons in two and a half months. It occurred despite the fact that some of them received this dose either protractedly, fractionally or in a single dose. Identical effects were observed if the whole dose was given during one treatment which lasted sixty-eight minutes or, if it was fractionated, in four or twenty treatments separated from each other by one week and

one day periods, and finally if each of twenty treatments lasting 68.2 minutes protracted the time exposure to twenty-two hours and forty-four minutes.

For the solution of the problem at hand the second series of experiments has advantages in two respects. First, the temperature conditions did not complicate this experiment. Second, the smaller dose, 2,000 r, did not produce a lethal effect so promptly, thereby allowing sufficient time for all the differently treated animal groups to show the possible differences in their reactions. Yet a more uniform rate of death of the experimental animals in all four groups testified to the fact that the lethal effect of the dose of 2,000 r total body roentgen irradiation in *Triton cristatus* was the same, regardless of how it was given.

It is valuable to compare these results with those obtained by Magath in mice (personal communication). A dose of 1,000 r during a single treatment caused the death of all treated mice soon after the irradiation. The same dose when divided into twenty parts and given during twenty days did not have a lethal effect. These results suggest that these two kinds of animals (triton and mouse) differ from each other in regard to the cumulative effect of roentgen radiation. The cumulative effect is most pronounced in tritons and therefore they reacted similarly to all the different methods of treatment. In mice the cumulative effect was not observed obviously as the dose administered in parts did not kill the mice as the single one did.

The results of this investigation point out once more the necessity of exercising great discretion in evaluating and transferring the conclusions regarding the biological effects of roentgen rays determined on the basis of the treatment of one kind of experimental animal to another. This can be illustrated by the fact that not only the distantly related organisms such as vertebrates and invertebrates react in a very different manner to the same treatment but even more closely related animals such as the mouse and the guinea pig differ strongly

in their reaction to the same dose of roentgen rays. The lethal dose for the mouse is 1,200 r, while for the guinea pig it is only 500 r (Ellinger¹⁹; see also Clark²⁰ and Henshaw²¹).

SUMMARY

The lethal effect of total body roentgen irradiation on adult tritons (*Triton cristatus*) is not dependent on the distribution of the dose in time. Obviously the triton is one of the animals which accumulates the small doses given during many days of protracted or fractionated treatment.

The authors wish to express their appreciation to Professor Frank H. J. Figge of the University of Maryland for valuable advice and suggestions concerning the preparation of this manuscript.

Department of Gross Anatomy
University of Maryland
School of Medicine
Baltimore 1, Md.

REFERENCES

1. HOLTHUSEN, H. Der Zeitfaktor bei der Röntgenbestrahlung. *Strahlentherapie*, 1926, 21, 275-305.
2. ZUPPINGER, A. Radiobiologische Untersuchungen an Ascariseiern. *Strahlentherapie*, 1928, 28, 639-758.
3. REGAUD, Cl., and FERROUX, R. Influence du "facteur temps" sur la stérilisation des lignées cellulaires normales et néoplasiques par la radiothérapie. *Arch. Inst. du Radium de l'Univ. de Paris*, 1929, 1, 343-358.
4. JÜNGLING, O., and LANGENDORFF, H. Über die Wirkung zeitlich verteilter Dosen auf den Kernteilungsablauf von *Vicia faba equina*. *Strahlentherapie*, 1932, 44, 771-782.
5. ZWERG, H. G. Die theoretischen, experimentellen, klinischen und wirtschaftlichen Grundlagen der protrahiert-fraktionierten Röntgenbestrahlung maligner Tumoren. *Strahlentherapie*, 1932, 43, 201-248.
6. SAX, K. The time factor in x-ray production of chromosome aberrations. *Proc. Nat. Acad. Sc.*, 1939, 25, 225-233.
7. MOTIDA, N., and ADATI, T. Lebenszyklus der Zelle und Strahlenintensität bei Bestrahlung. *Strahlentherapie*, 1939, 64, 468-476.
8. BAUER, R. Untersuchungen über die Einwirkung unterschiedlich verabfolgter Röntgenstrahlung auf das Knochenmark und seine Zellelemente, zugleich ein Beitrag zum Zeitfaktorproblem. *Strahlentherapie*, 1940, 67, 424-501.
9. LEA, D. E. The dependence of the biological

- effect of radiation on intensity and wave length, as measured by the delayed lethal action on chick embryos. *AM. J. ROENTGENOL. & RAD THERAPY*, 1941, 45, 605-613.
10. ELLINGER, F. *The Biologic Fundamentals of Radiation Therapy: A Textbook*. Elsevier Publishing Co., New York, 1941.
 11. LASNITZKI, I. The response of cells in vitro to variations in x-ray dosage. *Brit. J. Radiol.*, 1943, 16, 137-141.
 12. HUEPER, W. C., and DE CARVAJAL-FORERO, J. The effects of repeated irradiation of the gastric region with small doses of roentgen rays upon the stomach and blood of dogs. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 529-534.
 13. LAVEDAN, J. *L'action des radiations sur la cellule normale*. Gauthier-Villars, Paris, 1945.
 14. SAX, K. Analysis of x-ray induced chromosomal aberrations in *Tradescantia*. *Genetics*, 1940, 25, 41.
 15. ABELE, A. Versuche mit rhythmischer Bestrahlung von Eiern der *Drosophila melanogaster* Meig. *Strahlentherapie*, 1940, 67, 293-306.
 16. HERČIK, F., and MACHEK, R. Über den Einfluss des Zeitfaktors bei Wirkung der α -Strahlen. *Strahlentherapie*, 1940, 67, 100-109.
 17. LANGENDORFF, H., Das Verhalten der Salamandercornea nach einzeitiger und fraktionierter Röntgenbestrahlung. *Strahlentherapie*, 1943, 72, 505-526.
 18. FANO, U., and DEMEREC, M. Influence of time distribution of radiation treatment. In: *Medical Physics*. Otto Glasser, Editor. Year Book Publishers, Inc., Chicago, 1944, p. 510.
 19. ELLINGER, F. Lethal dose studies with x-rays. *Radiology*, 1945, 44, 125-142.
 20. CLARK, G. L. The effects of x-radiation on cell structure and growth; general survey of radiobiology. *Cold Spring Harbor Symp., Quant. Biol.*, 1934, 2, 249-263.
 21. HENSHAW, P. S. Experimental roentgen injury. II. Changes produced with intermediate-range doses and a comparison of the relative susceptibility of different kinds of animals. *J. Nat. Cancer Inst.*, 1944, 4, 485-501.



BIOLOGICAL EVALUATION OF 20 MILLION VOLT ROENTGEN RAYS*†

III. RECESSIVE SEX-LINKED LETHALS IN *DROSOPHILA MELANOGASTER*

By WILBUR M. LUCE, HENRY QUASTLER, and LESTER S. SKAGGS,

URBANA, ILLINOIS

THE connections between the quality of a radiation and its biological effectiveness are partly understood. If it is known how two kinds of radiation compare with respect to one biological reaction, one can predict, with a moderate degree of confidence, how they will compare with respect to another reaction of a similar nature. However, if one were to extend such predictions to biological reactions of a very different nature, he would be on very uncertain ground. Hence, in order to obtain a general idea of biological effects of any given radiation, it is necessary to test it over a wide range of reactions; and it is less important to have very many reactions than to have very diversified ones.

We are endeavoring to evaluate the biological effects of high energy roentgen rays produced by the betatron at 20 mev. Two reactions previously reported^{1,2} were a general and a local reaction of a mammal. We now add a local reaction in an insect: The production of recessive sex-linked lethals in the sperm of *Drosophila melanogaster*. This reaction has been widely tested before.³ It seems to occur whenever one ionization takes place within a target area of about 20 m μ . diameter. It is known that it is almost insensitive to changes of quality: no significant differences were found in the effects of soft and hard roentgen rays, beta and gamma rays. Neutrons are about two-thirds as effective as roentgen rays, for equal amounts of energy absorbed. Wide variations in the rate of delivery have little, if any, influence on the effect. Details of the experimental technique (for instance, the age of the sperm allowed to fertilize

ova) have some influence on the results, and there is some discrepancy among numerical values obtained by different observers. But the results obtained in any single laboratory are quite consistent.³

The mutagenic effect of radiations certainly belongs in any general testing program. For quantitative comparisons, mutation rates are converted into m , the mutation rate per 1,000 r.* Unfortunately, precise determinations of m are to be had only at the expense of a very considerable amount of work. If the dose administered was exactly 1,000 r, then m (in per cent) equals the percentage of sex-linked lethals, and its variance is given by the well known formula:

$$(1) \quad \text{Var } (m) = m(100 - m)/N$$

where N is the number of chromosomes tested, after irradiation with 1,000 r. As m is less than 3 per cent, $(100 - m)$ differs little from 100, and the variance of m is about equal to $100 m/N$. If the dose applied is k times 1,000 r, then the percentage of mutants is about k times m , and its variance equal to $k m(100 - k m)/N$. For the reaction range which can be used experimentally, $(100 - km)$ does not differ greatly from 100. Thus we find that, independent from the test dose applied,

$$(2) \quad \text{Var } (m) \simeq 100 m/N.$$

Suppose one wanted to determine a muta-

* Like most authors we are using the term "mutation rate" for the more correct but lengthy expression "rate of production of recessive sex-linked lethals." The justification of the term lies in the assumption that most mutations are recessive lethals, and that most recessive lethals are mutations.

* From the Departments of Physics and of Zoology, University of Illinois, Carle Foundation, Urbana, Illinois, and Michael Reese Hospital, Chicago, Illinois.

† This investigation was supported in part by a research grant from the National Cancer Institute of the National Institute of Health, United States Public Health Service.

tion rate within 10 per cent with a 95 per cent reliability. Mutation rates being about 2 per cent, this means that the standard deviation of m should be not more than one-half of 10 per cent of 2, or the variance not more than 0.01. This can be obtained by making N sufficiently large. Substituting 0.01 for $\text{Var}(m)$ in formula (2), one finds N equal to about 20,000. This represents about 3,500 hours of work.

We did not plan our *Drosophila* tests on a scale sufficiently large to obtain a precise determination of the relative effectiveness of the betatron high energy roentgen rays. We used a total of 5,289 chromosomes, which was sufficient to see whether mutation rate measurements yield results compatible with those obtained in previous tests with other reactions.

MATERIAL AND METHODS

The C/B test devised by H. J. Muller was used for the detection of the sex-linked lethals induced by roentgen rays. The test stocks, both of which were obtained from the Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, New York, chosen were *ec ct⁶ s car*/C/B and *g²pl*/C/B. The procedure followed was to treat 50–100 males, placed in size 00 gelatin capsules, of each stock with roentgen rays from the various sources, and then mate these treated males to virgin C/B females of the opposite stock. The F_1 C/B females were then mated in single female by several males matings in 8 dram shell vials. The males used in the F_1 matings were usually from the same stock as the original treated males.

In the examination of the offspring of the F_1 C/B females for lethals, only those vials in which a lethal had obviously occurred were classified as such. If there were any doubt due to small numbers of offspring or to the appearance of a few males, any proportion greater than 1 male to 50 females, such vials were classified as semi-sterile. An accurate count was also kept of the number of sterile vials. Although visible mutations induced by the roentgen rays

appeared in our tests no attention was given to these.

For the irradiations, three machines were used: the betatron, and conventional machines for deep and superficial therapy. For irradiations on the betatron, we built a phantom of sheets of presdwood, of such dimensions that if fitted into the space between the coilboxes. A channel in this phantom was aligned with the central ray. The target-near end of the channel was closed with a presdwood plug 6 cm. long, to insure the building up of electronic equilibrium. A Victoreen condenser thimble chamber was introduced into the channel, and a monitor instrument outside the phantom was calibrated against it. By substituting the flies for the thimble in the phantom, the doses administered to them could be accurately determined from the readings of the monitor. The dosage rates differed from experiment to experiment but were always of the order of several 100 r/min. For irradiation at 200 kv., the flies were placed into a cell in a large block of presdwood. The dosage rate was 100 r/min. For irradiation with 100 kv., the flies were placed upon a paraffin block near the target. The dosage rate was 1,600 r/min.

RESULTS

The results obtained are shown in Table 1. One sees that some results seem to be quite out of line, especially the betatron figures in Experiment No. 2. However, the total variability is about as expected.

Analyses of variance were performed with respect to several factors which could be suspected to influence the results. A negative result, i.e., no significant effect upon the mutation rates, was found for the following factors: single experiments vs. total average, high vs. low dosage level, strain *ec ct⁶ s car* vs. *g² pl*. This leaves technique of irradiation as a potentially significant factor. The following weighed averages were calculated: betatron: $m=1.4$ with a standard deviation of ± 0.3 ; 200 kv.: 2.5 ± 0.4 ; 100 kv.: 1.6 ± 0.4 . The difference between the two low energy

TABLE I
EXPERIMENTAL RESULTS

Experiment No. and Date	Machine	Dose in 10^{-3} r	Strain ec ct ⁶ s car				Strain g ² pl			
			No. chromo- somes tested	No. fertile	No. fertile with- out males	m	No. chromo- somes	No. fertile	No. fertile with- out males	m
1 Jan. 10, 1947	betatron	1.755 2.94	124 135	118 132	4 12	2.0 3.2	136 132	133 121	6 8	2.6 2.3
	superficial	3.3	127	117	5	1.3	130	118	9	2.4
	deep	2.84	135	134	13	3.6	129	122	9	2.7
	—	0	137	137	0	—	135	130	0	—
2 May 14, 1947	—	0	105	100	0	—	105	103	0	—
	betatron	3.01 6.02	109 110	95 93	2 10	0.7 1.9	110 106	101 90	2 4	0.7 0.7
	deep	3.0 6.0	103 53	89 43	10 13	4.0 6.0	110 111	103 75	7 8	2.3 1.9
	superficial	3.0 6.0	119 48	98 15	10 2	3.6 2.4	110 89	92 61	3 6	1.1 1.5
3 Nov. 12, 1947	—	0	104	100	0	—	105	98	0	—
	betatron	2.30 4.70	119 119	113 109	8 11	3.2 2.3	120 120	94 97	3 8	1.4 1.8
	deep	3.16 6.32	120 105	106 88	9 7	2.8 1.3	120 121	106 91	12 11	3.8 2.3
	superficial	3.25 6.52	120 54	114 50	5 2	1.4 0.6	124 57	113 45	7 6	2.0 2.2
4 Jan. 31, 1948	betatron	2.98 5.9	84 66	78 64	4 7	1.8 1.9	129 36	125 28	9 5	1.4 3.3
	deep	3.16 6.32	83 84	82 74	4 10	1.6 2.3	113 105	109 93	7 13	2.1 2.4
	superficial	3.75 7.5	123 35	122 33	6 5	1.3 2.2	119 94	114 78	10 10	2.5 1.8

machines is not necessarily significant; a difference of this size might be expected, on the basis of random sampling, about once in eight tests. In this respect it compares to published results about effects of quality and dosage rate; the material published does not prove the presence of

quality and dosage rate effects, but it certainly does not exclude them either.

The weighed average mutation rate per 1,000 r, for the two low energy machines combined, is 2.0 ± 0.3 , or 0.6 ± 0.4 larger than that for the betatron. Again, the difference is not significant; it would occur,

by chance, in one test out of six. However, in this case we have no reason to believe that the factor should be equal to 1.0. Hence, we take the figures as they stand as the best estimate, which means that 1 r as measured in the betatron beam by a 25 r Victoreen condenser chamber, has the mutagenic effect of roughly 0.7 r of conventional rays. No great precision is claimed for this factor.

DISCUSSION

The induction of sex-linked recessive lethals is the third biological test reaction we have used to compare the biological effectiveness of high energy and low energy roentgen rays. As in the previous tests, it was found that high energy rays are less effective per unit dose as read by a physical instrument. The factor found this time is 70 per cent, as compared to 72 per cent found in testing the decoloration of hair in mice, and to 79 per cent obtained with survival time of mice after total body irradiation. The factors found are similar, possibly identical. We have pointed out before that the nature of this conversion factor can be determined only if an absolute measurement of high energy rays is performed. Such an absolute measurement implies a re-definition of dosage units. The arbitrariness of the 25 r thimble as a standard is shown by the fact that thimbles

of different capacity (25 r, 100 r, 250 r), properly standardized for rays of conventional energies, give discordant readings in the betatron beam—the smaller the chamber, the higher it reads in the betatron beam.

SUMMARY

1. The mutagenic effect of roentgen rays has been investigated by means of the C/B test in *Drosophila melanogaster*. Three types of apparatus were used: the betatron, and conventional machines for deep and superficial therapy.

2. The results obtained are consistent with an effectiveness of 70 per cent of the high energy rays, as compared to low energy rays, both referred to the 25 r condenser thimble as the common standard.

Henry Quastler
Physics Dept., University of Illinois
Urbana, Ill.

REFERENCES

1. QUASTLER, H., and CLARK, R. K. Biological evaluation of 20 million volt roentgen rays. I. Acute roentgen death in mice. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 723-727.
2. CHASE, H. B., QUASTLER, H., and SKAGGS, L. S. Biological evaluation of 20 million volt roentgen rays. II. Decoloration of hair in mice. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 57, 359-361.
3. LEA, D. E. *Actions of Radiations on Living Cells*. Cambridge University Press, 1947.



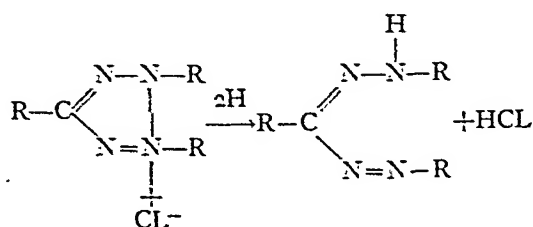
RADIATION EFFECTS ON 2, 3, 5-TRIPHENYLTETRAZOLIUM CHLORIDE SOLUTIONS

By Z. S. GIERLACH and A. T. KREBS
Medical Department, Field Research Laboratory
FORT KNOX, KENTUCKY

I. INTRODUCTION

2, 3, 5 - Triphenyltetrazolium chloride (TTC) was first synthesized in 1894 by von Pechmann and Runge.¹¹ Kuhn and co-workers^{6,7} took up the study in 1941 and reported, among other properties, its oxidation reduction potential, namely, -0.08 volt in the pH range 5.7 to 6.8. Attention to this substance in America was brought about by the work of Dutcher⁴ who reviewed the work of Lakon⁵ on topographical staining and analysis of grain seed. Porter, Durrell and Romm¹² also reported on its use as an indicator of seed viability. Cottrell³ confirmed Lakon's work in 1947, as did also Shuel.¹⁵ Mattson, Jensen and Dutcher¹⁰ used it as a test reagent for checking vitality of tissues other than seeds. Waugh¹⁹ then used this salt as a stain for living stem tissue and leaves. Pratt, Dufrenoy and Pickering¹³ proposed it as a reagent in cellular physiology. Straus, Cheronis and Straus¹⁸ were the first to explore its uses in animal tissue, both normal and malignant.

According to the above published works, the formula for TTC and its reduced state is:



Because of its low reduction potential, this colorless water soluble tetrazol is easily reduced by chemical as well as phytochemical means to its red, water-insoluble, nondiffusible formazan.

Noticing that ultraviolet light influenced solutions of this salt, it was believed important to explore this phenomenon further,

not only studying light, but also other radiations.

II. EXPERIMENTAL

A. Methods and Procedures.

1. Photochemical Investigations. The first investigations into the effect of ultraviolet light on TTC were started with fluorescence equipment assembled for work with fluorescent vital stains. It consisted of an ordinary microscope, ultraviolet light source and eye protective filter. Illumination source was a Leitz carbon arc lamp with a Beckman B-2 and B-4 filter combination. The eye protective filter was a Wratten K-3 located in the eyepiece. To obtain better efficiency, the standard microscope mirror was replaced by an aluminized front surface mirror.

Doing vital staining work with *Allium cepa* epidermis and modern fluorochromes, TTC was also included in the investigations. It was noted that a section of living onion epidermis subjected to TTC solution became pink. This was expected according to the published work. However, while observing this preparation in the fluorescence equipment, it developed in addition to the normal pink color, a bright red spot. To be certain that this was not due to a possible stimulation of cellular activity, a clear drop of TTC solution was placed on a glass slide and observed under identical conditions. Here also, the red precipitate was formed. With the formation of the red spot, fluorescence appeared in the field and increased in intensity to saturation during the observation period.

In systematic investigations, the nature of the red precipitate was determined, also the effective reduction wavelength, the effect of temperature, pH, concentration, intensity of light and exposure time. For

these purposes, aqueous TTC solutions and TTC gelatin emulsions of known concentration, as noted in graphs, were prepared. The chemical was dissolved in distilled water with the pH normally adjusted to 6.0 with phosphate buffer; for special investigations, solutions with pH ranges from 1.3 to 11.0 were prepared. The TTC emulsions contained in general 10 per cent gelatin and 1 per cent TTC.*

A series of varying exposures under standard irradiation conditions was made. Samples were exposed in the appropriate cuvettes and also as emulsions on 4 by 5

cially useful. The results obtained were later verified by exposure of gelatin emulsion plates in the large Littrow quartz spectrograph using, for slit illumination, either National Super-Tan carbons or the Hanovia Alpine mercury lamp. The exposure times were variable up to six hours.

2. Radiochemical Investigations. This work was extended from the photochemical into the radiochemical regions. Both alpha rays and roentgen rays were investigated.

For the alpha-ray work, three polonium preparations were available.† The polonium was deposited on nickel foil 5 by 5 sq. mm.

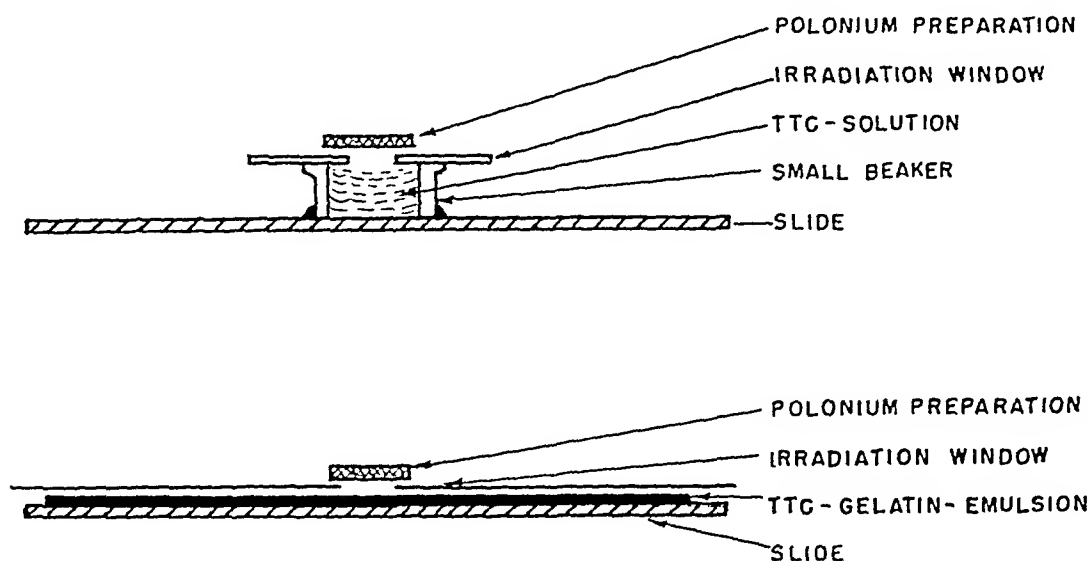


FIG. 1. Schematic diagram of alpha irradiation setup.

inch glass plates. Density measurements of the cuvettes were made in a Beckman quartz spectrophotometer. The density measurements of the plates were made with a Weston densitometer and later with the self-recording General Electric spectrophotometer. This instrument was also used to identify the photochemically produced red substance with chemically reduced TTC (zinc-reduction) by comparing the absorption spectra. Irradiation sources were the sun, the Hanovia U-burner and the Hanovia Alpine lamp. For studying the effective wavelengths, the above sources were filtered by Corning or Wratten filters. Filters with sharp cutoffs or monochromats were espe-

in size. Their strength as of August 23, 1948, was: Preparation No. 1—2 millicuries; Preparation No. 2—0.1 millicurie; Preparation No. 3—0.0004 millicurie.

Solutions and emulsions of the same concentration as used in the photochemical work were also taken in this study. The alpha-ray bombardment was made in such a way as to capture the maximum energy of the alpha particles in the preparation. Details are shown in Figure 1.

The density of the alpha-particle-produced formazan in the plates was measured with the Weston densitometer.

The roentgen-ray exposures were carried out with aqueous TTC solutions and TTC emulsions that were sealed in small vials of

* TTC from 2 sources: was used: (1) The Arapahoe Chemical Co., Inc., Boulder, Colorado; and (2) The Pannone Chemical Company, Farmington, Connecticut.

† Obtained from Canadian Radium and Uranium Corporation, 630 Fifth Ave., New York 20, N. Y.

3 cc. each. These samples were exposed at a rate of 250 r per minute measured in air and up to 130 minutes total irradiation time. The irradiation was done with 550 kv. roentgen rays through a composite filter equivalent to 9 mm. of copper.

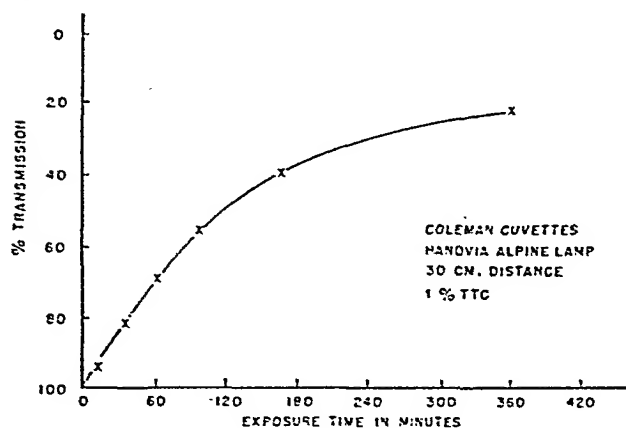


FIG. 2. Reduction of TTC solution by ultraviolet light.

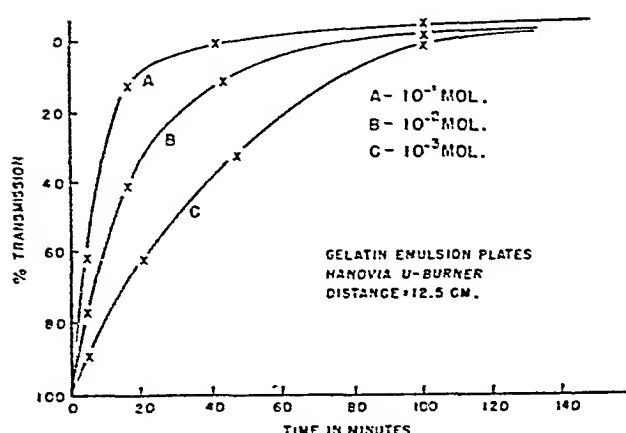


FIG. 3. Reduction of TTC solution by ultraviolet light: Effect of concentration.

B. Results.

The following results were observed:

1. By irradiating aqueous solutions of the clear, water-soluble 2,3,5-triphenyltetrazolium chloride with ultraviolet light, this chemical was reduced to its red water-insoluble formazan.

2. The reduction depends on the radiation wavelengths. Wavelengths longer than 3,650 Å do not reduce, whereas wavelengths between 3,650 Å and 2,536 Å reduce effectively. The 2,536 Å region was the lowest at our disposal.

3. The amount of formed precipitate is determined by the intensity of the light

source, and/or the time of exposure. Figure 2 shows that graduated exposures give an increasing density.

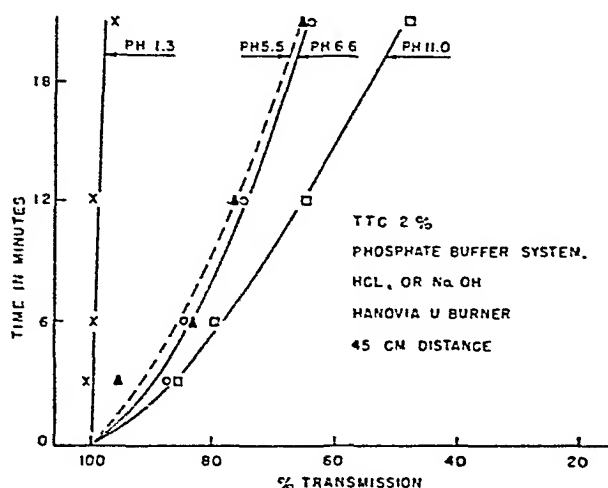


FIG. 4. Reduction of TTC solution by ultraviolet light: Effect of pH.

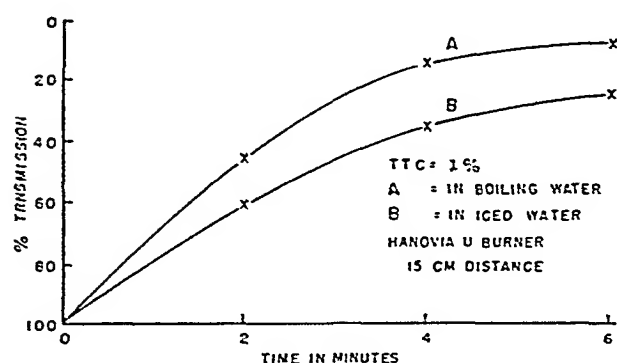


FIG. 5. Reduction of TTC solution by ultraviolet light: Effect of temperature.

4. The rate of formation of the red precipitate increases with increase of concentration. The radiation effects are more pronounced in the early time intervals as shown in Figure 3.

5. The pH influence, noticed early by Jerchel and Möhle,⁶ also exists in irradiation reduction. The reduction rate is the same in pH range 5.5 to 6.6 where also the reduction potential is constant (see Fig. 4).

6. Higher temperatures accelerate the reduction process. For example, with a temperature difference of 100° C. (0°–100° C.) and at a two minute irradiation under the chosen standard conditions, there is 15 per cent difference in transmission (see Fig. 5).

7. Alpha rays from polonium sources behave in a manner similar to ultraviolet light. Also here, tetrazolium in aqueous solution or in a gelatin emulsion is reduced to red formazan. The millicurie strength, the exposure time and the concentration of the tetrazolium are significant (see Fig. 6).

8. Roentgen rays also reduce TTC solutions. The amounts necessary are relatively

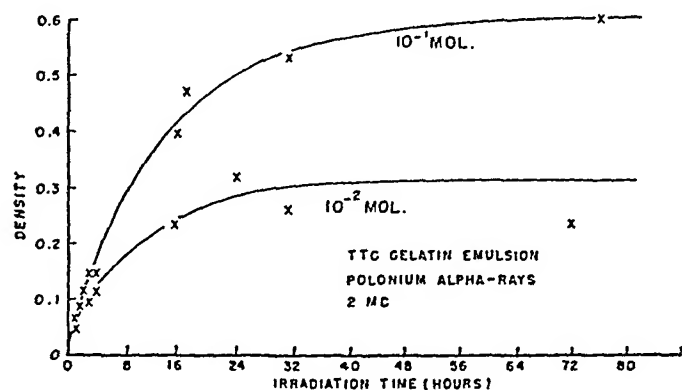


FIG. 6. Reduction of TTC solution by alpha rays from polonium.

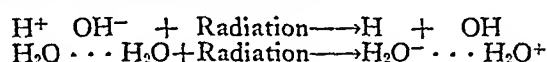
high. The earliest visual effect was produced by 32,000 r measured in air.

III. DISCUSSION

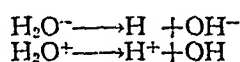
The observed results raise the question as to the mechanism of these effects.

TTC is reduced, according to chemical knowledge, by taking up hydrogen atoms. Consequently, hydrogen atoms must be produced by irradiation.

That ionizing radiation converts water molecules into free hydrogen atoms and hydroxyl radicals has been postulated by the theory of Weiss.²⁰ According to Weiss, in the irradiation of water, the following electron transfers occur:



followed by:



All of these processes are energetically possible and have been confirmed independently by photochemical evidence.

The produced hydrogen atoms and

hydroxyl radicals are chemically very reactive^{5,21} and if there are in the solution appropriate acceptors, they will react with these radiation products. Since biological systems are primarily solutions, the radiobiological implications of the above statements become apparent. So, for instance, dissolved oxygen in water is such an acceptor and irradiation leads to the production of H_2O_2 . Such an acceptor, favored by the low reduction potential, must be also tetrazolium chloride.

The production of the effect by ultraviolet light with wavelengths up to 3,650 Å requires further investigation. It may be explained by a direct effect on TTC, so that similar to photosynthetic processes (Rabinowitch¹⁴) excited intermediate states are formed (Rossi^{14a}). The observed fluorescence, which increases with the irradiation time, favors this hypothesis.

There may also be an explanation on the basis of the data given by Lea. According to Lea,⁹ 5 electron volts (ev.) are required to convert water into H and OH radicals. The wavelength 2,536 Å has a quantum energy of 4.89 ev. an amount close to the number given by Lea, but very dissimilar to the known water dissociation energy of about 13 ev.¹⁶ Further investigations, especially into the ionic yield, will give additional data and also new insight as to the parallelism between photochemical and radiochemical effects.

To a certain degree, these results and this discussion of the photochemical and radiochemical behavior of TTC solutions are a further contribution to the theory of Weiss on the effects of radiation on water and aqueous solutions as it has been discussed and used by Lea⁹ and at the conference in London on "Certain Aspects of the Action of Radiation on Living Cells,"¹⁷ and by Barron² at the Forty-Ninth Annual Meeting of the American Roentgen Ray Society, 1948.

IV. SUMMARY

Previous investigations have shown that TTC solution can be reduced chemically.

These experiments show that this substance can also be reduced by photochemical and radiochemical means.

Factors influencing this reduction, such as tetrazolium concentration, intensity of radiation, time of exposure, pH and temperature, were investigated. It is believed that this study is an experimental contribution to the theory of Weiss on the radiochemistry of aqueous solutions.

Following this exploratory work more extensive studies should be undertaken as to different types of radiation, amounts of each necessary to reduce tetrazolium, and especially as to exact ionic yield.

Other substituted tetrazolium salts such as neotetrazolium¹ and 2,3 diphenyl-5 methyl-tetrazolium should be studied as to their radiochemical behavior.

We wish to express our gratitude to Kenneth E. Corrigan, Ph.D. of Harper Hospital, Detroit, Michigan, who carried out the roentgen irradiation for us; also, to Dr. Hans F. Jensen of this laboratory for advice and encouragement.

Medical Department
Field Research Laboratory
Fort Knox, Kentucky

REFERENCES

1. ANTROPOL, W., GLAUBACH, S., and GOLDMAN L. Effects of a new tetrazolium derivative on tissue, bacteria, and onion root tips. *Pub. Health Rep.*, 1948, 63, 1231.
2. BARRON, E. S. G. The effect of ionizing radiations on enzymes and proteins. Presented at 49th Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.
- 2a. BARRON, E. S. G. *et al.* Studies on the mechanism of action of ionizing radiations. I. Inhibition of action of enzymes by x-rays. *J. Gen. Physiol.*, 1949, 32, 537.
3. COTTRELL, H. J. Tetrazolium salt as a seed germination indicator. *Nature*, 1947, 159, 748.
4. DUTCHER, R. A. See reference 10.
5. HEVESY, G. On the effect of roentgen rays on cellular division. *Rev. Mod. Physics*, 1945, 17, 102.
6. JERCHEL, D., and MÖHLE, W. Die Bestimmung des Reduktionspotentials von Tetrazolium Verbindungen. *Ber. d. deutsch. chem. Gesellsch.*, 1944, 77, 591.
7. KUHN, R., and JERCHEL, D. Ueber Invertseifen. VII. Tetrazoliumsalze. *Ber. d. deutsch. chem. Gesellsch.*, 1941, 74B, 941.
8. LAKON, G. Topographischer Nachweis der Keimfähigkeit der Getreidefrüchte durch Tetrazoliumsalze. *Ber. d. deutsch. bot. Gesellsch.*, 1942, 60, 299.
9. LEA, D. E. Actions of Radiations on Living Cells. Macmillan Company, New York, 1947.
10. MATTSON, A. M., JENSEN, C. O., and DUTCHER, R. A. Triphenyltetrazolium chloride as a dye for vital tissues. *Science*, 1947, 106, 294.
- MATTSON, A. M. The preparation and biochemical uses of certain tetrazolium salts. Master Thesis, Pennsylvania State College, 1947.
11. VON PECHMANN, H., and RUNGE P. Oxydation der Formazylverbindungen. *Ber. d. deutsch. chem. Gesellsch.*, 1894, 27, 2920.
12. PORTER, R. E., DURRELL, M., and ROMM, H. J. The use of 2,3,5-triphenyltetrazolium chloride as a measure of seed germinability. *Plant Physiol.*, 1947, 22, 149.
13. PRATT, R., DUFRENOY, J., and PICKERING, V. L. Triphenyltetrazolium chloride, a valuable reagent in stain technology. *Stain Technol.*, 1948, 25, 137.
14. RABINOWITCH, E. I. Photosynthesis and Related Processes. Interscience Publishers, Inc., New York, 1945.
- 14a. ROSSI, H. H. The biological significance of the tissue dose of ionizing radiations. *Tr. New York Acad. Sci., Ser. II*, 1949, 11, 270.
15. SHUEL, R. W. Seed germinability tests with 2,3,5-triphenyltetrazolium chloride. *Sc. Agr.*, 1948, 28, 34.
16. SMYTH, H. D., and MUELLER, D. W. The ionization of water vapor by electron impact. *Phys. Rev.*, 1933, 43, 116.
17. SPEAR, F. G. Report of London conference held May 13-14, 1946, on "Certain Aspects of the Action of Radiation on Living Cells." *Brit. J. Radiol.*, 1947, suppl. I.
18. STRAUS, F. H., CHERONIS, N. D., and STRAUS, E. Demonstration of reducing enzyme systems in neoplasms and living mammalian tissues by triphenyltetrazolium chloride. *Science*, 1948, 108, 113.
19. WAUGH, T. D. Staining of stem tissues of plants by triphenyltetrazolium chloride. *Science*, 1948, 107, 275.
20. WEISS, J. Some aspects of the chemical and biological actions of radiations. *Tr. Farad. Soc.*, 1947, 33, 314.
21. WEISS, J. Radiochemistry of aqueous solutions. *Nature*, 1944, 153, 748; Biological action of radiations, *ibid.*, 1946, 157, 584.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

OIL CONTRAST

A NEW METHOD OF EXAMINATION OF THE GASTRIC MUCOSA

By CESARE GIANTURCO, M.D.

Carle Hospital Clinic

URBANA, ILLINOIS

THE roentgen examination of the stomach is not complete without a roentgenographic or roentgenoscopic study of the mucosa. This is usually done by graduated compression of the walls. There are, however, portions of the stomach which are inaccessible to compression and there are stomachs which are completely

sults they cannot be used as routine because of the discomfort they cause, and because the amount of gas is not easily controllable.

A good double contrast, however, can be obtained in the great majority of patients if, following the ingestion of one-half glass of barium, one administers one-half glass



FIG. 1

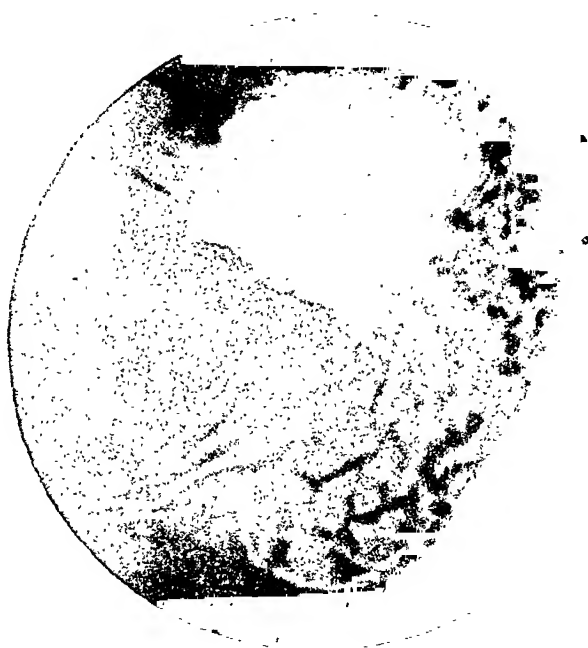


FIG. 2

protected by the costal arch. Because of this, attempts were made to obtain a double contrast visualization of the gastric mucosa by the insufflation of air, by means of effervescent powders or by the introduction of air-filled balloons. Although these methods may occasionally give good re-

sults they cannot be used as routine because of the discomfort they cause, and because the amount of gas is not easily controllable. A good double contrast, however, can be obtained in the great majority of patients if, following the ingestion of one-half glass of barium, one administers one-half glass

double contrast visualization. The oil contrast method can be used following any technique of examination. After the ingestion of oil, the patients should be examined in the upright position (Fig. 1) and in the supine-Trendelenburg position (Fig. 2). The upright position will show the mucosa of the upper half of the stomach, while the supine position will show the mucosa of the

body of the stomach and of the antrum.

The oil contrast method will be unsatisfactory in those stomachs which contain an excessive amount of food or mucus. The administration of mineral oil also helps to prevent barium impactions.

Carle Hospital Clinic
Urbana, Ill.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. *Foreign*

Collaborators: GÖSTA FORSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San Jose, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.; *Secretary:* H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio.

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fiftieth Annual Meeting: Netherland Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949.

AMERICAN RADIUM SOCIETY

President: Maurice Lenz, New York, N. Y.;
President-Elect: William S. MacComb, New York, N. Y.; *1st Vice-President:* Leland R. Cowan, Salt Lake City, Utah; *2nd Vice-President:* James A. Corscaden, New York, N. Y.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: William E. Costolow, Chairman, Los Angeles, Calif., Charles L. Martin, Dallas, Texas, A. N. Arneson, St. Louis, Mo.

Program Committee: William S. MacComb, Chairman, New York, N. Y., James F. Nolan, Los Angeles, Calif., John E. Wirth, Baltimore, Md., John V. Blady, Philadelphia, Pa.

Publication Committee: Edward H. Skinner, Chairman, Kansas City Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Research and Standardization Committee: Robert B. Taft, Chairman, Charleston, S. C., Jacob R. Freid, New York, N. Y., K. W. Stenstrom, Minneapolis, Minn.

Education and Publication Committee: James A. Corscaden, Chairman, New York, George C. Andrews, New York, A. N. Arneson, St. Louis, Mo.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: E. P. Pendergrass, Chairman, Philadelphia, Pa., John F. Hynes, Wilmington, Del., P. C. Swenson, Philadelphia, Pa.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., J. E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: 1950, to be announced.



CONGENITAL CYSTIC DISEASE OF THE LUNG

THE stimulus to interest in this subject in this country is generally credited to Koontz.¹ This is in some ways remarkable for his paper appeared in a journal not of large circulation and contained a single case report of an infant who died with a variety of disorders, among which were cavities and inflammatory infiltration in the lungs. The paper did contain, however, an extensive review of the literature and a summary of the findings in 108 cases of cystic disease and other pulmonary malformations mostly from the German literature. According to Koontz, no cases of congenital cystic disease of the lung had yet appeared in the American literature. From this study of reported cases he raised the question whether pulmonary cavities result from pulmonary infection or whether pre-existing cavities of developmental origin predispose to a secondary pulmonary infection, and he concluded that the decision is to be made by a careful microscopic examination of the wall of the cavity and adjacent bronchi for evidence of a congenital anatomical malformation. This had not always been evident in the reported cases. Congenital cystic disease of the lung may be regarded fundamentally as a bronchial malformation with an obstruction between the cysts which have a bronchial type of epithelial lining, and the bronchial tree proper.

Subsequent reports indicated that the disease was not at all rare; in fact, the diagnosis of congenital cystic disease was applied without rigid criteria to a variety of pulmonary lesions which we would not

now accept. Some of these were certainly emphysematous bullae in the aged, and in children there were cases of transient localized obstructive emphysema occurring in the course of pneumonia described by Benjamin and Childe² and by Caffey.³ Probably many cases of chronic lung abscess and chronic bronchiectasis have also been mislabelled congenital cystic disease or congenital bronchiectasis. In time, considerable skepticism developed concerning the existence of this condition and several roentgenologists of wide experience and even pediatric roentgenologists asserted that they had not to their knowledge encountered such a disease. There has unfortunately been confusion concerning the use of the terms "cyst" and "cystic" in acquired lesions. Perhaps one should not object to this usage for the terms are properly applied to acquired lesions in other organs and such an acquired lesion as an echinococcus cyst is universally accepted as properly labelled. In general, however, the use of the term "cystic disease" for acquired lesions in the lung is misleading, ambiguous and to be avoided. It seems fair to state that the diagnosis of congenital cystic disease of the lung becomes more uncertain and improbable the older the patient. At best the diagnosis was then largely of academic and pathological interest for, as Miller⁴ stated in 1926, "a radical cure is out of the question."

This situation was entirely changed by the development of thoracic surgery and

² Benjamin, B., and Childe, A. E. Localized bullous emphysema associated with pneumonia in children. *J. Pediat.*, 1939, 15, 621-639.

³ Caffey, J. Regional obstructive pulmonary emphysema in infants and in children. *Am. J. Dis. Child.*, 1940, 60, 586-605.

⁴ Miller, R. T., Jr. Congenital cystic lung. *Arch. Surg.*, 1926, 12, 392-405.

¹ Koontz, A. R. Congenital cysts of the lung. *Bull. Johns Hopkins Hosp.*, 1925, 37, 340-361.

the demonstration that cysts or portions of lung containing cysts could be removed. Such a successful operation was reported in an infant in 1943 by Fischer, Tropea and Bailey.⁵ There have been sufficient subsequent reports to show conclusively that the disease does exist, that it is not extremely rare and that surgery is feasible even in the youngest infants.

Probably the largest series of cases personally observed and treated surgically is contained in the paper of Ravitch and Hardy.⁶ They report 12 cases from the Johns Hopkins Hospital, 8 of which were seen in the year before the paper was written. They emphasize the ease and frequency with which cysts become infected and that in such a situation an erroneous diagnosis of chronic empyema or chronic lung abscess is often made. In cases of uninfected expansile air cysts the mistaken

diagnosis of pneumothorax and diaphragmatic hernia must be avoided. While they concede that "The diagnosis is based largely on the roentgenographic appearance of the lesions and has usually been fairly obvious," they state that "The ultimate criterion for the diagnosis of congenital cystic disease of the lung in most cases is the gross and microscopic pathologic picture."

The lesson to be drawn from recent studies is that expansile air-containing segments of lung which threaten the function of the remaining lung and chronically suppurating and/or recurrently hemorrhagic lesions in the lung should be treated by surgical removal of the lesion and that the lesion when examined pathologically, especially in infants and children, will often be found to have as a basis an anatomical malformation which may be classified as congenital cystic disease with a malformation of the bronchi.

WILLIAM A. EVANS, JR., M.D.

⁵ Fischer, C. C., Tropea, F., Jr., and Bailey, C. P. Congenital pulmonary cysts. *J. Pediat.*, 1943, 23, 219-223.

⁶ Ravitch, M. M., and Hardy, Janet B. Congenital cystic disease of the lung in infants and in children. *Arch. Surg.*, July, 1949, 59, 1-36.



SIDNEY CONROY BARROW

1876-1948

DR. SIDNEY CONROY BARROW died of coronary occlusion on August 11, 1948.

He was born in West Feliciana Parish, Louisiana, November 22, 1876. He attended Centenary College and graduated in 1896. He received his Doctor of Medicine from the University of Tennessee in 1901. He moved to Shreveport, Louisiana, in 1906 and began the practice of radiology which he continued until his death.

Dr. Barrow was a pioneer radiologist in Louisiana, and for a good many years was the only radiologist in Shreveport. He served as radiologist to Shreveport Charity Hospital, Tri-State Hospital, North Louisiana Sanitarium and Schumpert Sanitarium. In 1920 he became associated with Dr. W. R. Harwell and this association continued until his death. In his later years he relinquished his active hospital appointments and confined his practice to consultation and the private practice of radiology.

Dr. Barrow was very active in medical society circles. He became president of the Shreveport Medical Society and served as president of the Louisiana State Medical Society in 1932. He became a member of the American Roentgen Ray Society in 1919. He was elected a Fellow of the American College of Radiology in 1926. He was a member of the Radiological Society of North America, the American Medical Association, Louisiana State Medical Society, Shreveport Medical Society and the Shreveport Radiological Club.



Sidney Conroy Barrow

Until recently Dr. Barrow led an active life and made many friends throughout Louisiana and the Southwest. He will be missed by many associates in the medical profession and a host of friends and acquaintances.

JOHNSON R. ANDERSON, M.D.



MONICA DONOVAN

1892-1948

DR. MONICA DONOVAN, a member of the American Roentgen Ray Society since 1922, died on December 29, 1948. She was born February 2, 1892, the daughter of Michael J. and Elizabeth M. Donovan, and lived all her life in San Francisco. She received her A. B. from Stanford University in 1914 and her M.D. in 1917. After serving an internship in the Stanford-Lane Hospital she remained in the Department of Roentgenology and for a number of years was instructor in the Medical School. For many years she was head of the department in St. Mary's

Hospital, and she maintained offices at 450 Sutter Street for twenty years.

Dr. Frances Moffett, a former resident on her service, stated in the March issue of the *Bulletin of the San Francisco County Medical Society*, "Dr. Donovan was noted for the professional encouragement and financial help she gave many of her younger colleagues. She was also greatly interested in the San Francisco College for Women, to which she devoted much time. She was loved by many and will be missed by all who knew her."

RAMSAY SPILLMAN, M.D.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4-7, 1949.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1950, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill. Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY

Secretary, D. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. through April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg.,

Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. F. H. Ghiselin, 111 East 76th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Boyd Isenhardt, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. G. P. Keefer, 1930 Chestnut St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. K. C. Corley, 1835 Eye St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO**SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA**

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:

New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. I. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. R. de G. Burnard, 170 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA**SOCIEDAD ARGENTINA DE RADIOLOGIA**

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGÍA, FILIAL DEL LITORAL

President, Dr. Francisco P. Cifarelli. Meets second

Wednesday each month, at 7:00 P.M., at 663 Italia St. in Rosario.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Andreilino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE**SOCIÉTÉ BELGE DE RADIOLOGIE**

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloristr. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

MASS GASTRIC ROENTGENOLOGICAL SURVEYS FOR CONTROL OF GASTRIC CANCER

To the Editor:

Dr. Sherwood Moore,¹ in his paper in this JOURNAL for April, 1949, points out the great potential value of mass gastric roentgenological surveys for control of gastric cancer when he states, "It could, if found feasible, save many lives." A diagnostic procedure that could save many lives should not be discouraged, especially in the experimental stage, for other than weighty reasons. It is important, therefore, to examine closely the reasons which Dr. Moore advances in opposition to this method.

Dr. Moore presents the following arguments against mass gastric surveys:

1. "The high incidence of gastric cancer is exaggerated." (p. 470)
2. It "would require far more radiologists than are available for that purpose." (p. 471)
3. "There would be enormous risk to the roentgenoscopist." (p. 471)
4. It "is a very uncertain way of detecting any early lesion." "... it is the early lesion that is most likely to be overlooked by any part of the roentgen examination." (p. 471)
5. According to Kirklin and Hodgson, "It would be necessary to examine individuals every three months, which, for the whole adult population, is an absurdity." (p. 471)

With respect to point one, Dr. Moore presents data on 1,352 carcinomas of the gastrointestinal tract diagnosed by roentgen examination, presumably at the Edward Mallinckrodt Institute of Radiology,* from 1916 to 1947, inclusive. Of these, 45.8 per cent were gastric, 27.2 per cent were of the large intestine, 18.8 per cent were of the esophagus, 8.2 per cent were of the rectum, and 0.2 per cent were of the small intestine. Dr. Moore interprets these figures to mean that "if all gastric cancers

were diagnosed early by mass methods, there would remain a large number of cancers elsewhere in the tract that would escape detection." This amounts to a plea against mass detection of one type of cancer because the method used would not detect other types. By the same reasoning, one would reject attempts to detect carcinoma of the uterus by the vaginal smear technique, because cancer of the breast is not also detected by this method, or cancer of the skin, or of the ovaries, etc. Certainly, the ideal detection examination would be one with a high percentage of efficiency of detecting early, asymptomatic cancer wherever it may occur in the body. This ideal probably will be achieved only when appropriate individual detection techniques for each organ are developed. These techniques must be developed separately for each organ, since each presents special diagnostic problems. Even the discovery of a test, such as a serological examination, that would indicate the presence or absence of cancer *anywhere* in the body would leave the problem of determining in which organ the cancer was located. Hence, the further development of detection tests for organs like the stomach, in which cancer occurs frequently and for which a promising examination method is available, is of importance, from any standpoint.

The incidence and mortality of gastric carcinoma unfortunately require no exaggeration. Gastric carcinoma was certified as the cause of death of 25,625 persons in the United States in 1946.² It is the most frequent form of cancer causing death among males, accounting for 18.0 per cent of all male cancer deaths, and the fourth most frequent form among females, accounting for 10.3 per cent of female cancer deaths. The annual incidence of new cases among the population aged forty and over in New York State in 1945-1947 was 46 per 100,000.³ With present methods of diagnosis and treatment, the average five

¹ Moore, S. Mass roentgenological survey of the gastrointestinal tract to detect cancer of the stomach. AM. J. ROENTGENOL. & RAD. THERAPY, April, 1949, 67, 470-474.

* "About half of these cases were from the Edward Mallinckrodt Institute of Radiology and the other half were from its predecessor, the X-Ray Department of the Washington University Medical School. Methods and equipment were the same in both places."—Sherwood Moore.

² Selected Facts and Figures on Cancer, The American Cancer Society, February, 1949.

³ Bureau of Cancer Control, New York State Department of Health.

year cure rate is reliably estimated at less than 5 per cent, whereas the five year cure rate for all resected lesions is approximately 25 per cent. If mass detection were successful in detecting only one-half of lesions in the resectable stage, the saving of lives would be approximately $\frac{1}{2} \times 25$ per cent $\times 25,625$, or 3,203 lives. It would appear that the incidence and mortality of gastric carcinoma are sufficiently great to justify efforts to improve early diagnosis and to increase the present low cure rate by any feasible means, including mass gastric surveys.

With respect to points two, three, and four above, these objections to mass gastric surveys are all based on the assumption that the sole method which can be used is that of examination by roentgenoscope, followed by roentgenograms. This time-consuming method would indeed limit the number of examinations performed and would virtually exclude the possibility of examining any large proportion of the adult population at frequent intervals. Even with this limitation, there would still remain the possibility of employing this method of detection in selected groups of the population known to have an increased risk of developing gastric carcinoma. Examples of such groups would be: males aged sixty-five and over, in which the annual incidence of stomach cancer is 123 per 100,000; pernicious anemia patients, in which Rigler and Kaplan⁴ found an incidence of 6.9 per cent carcinoma and 6.6 per cent of gastric polyps⁵; and the "precursor group" studied at the University of Minnesota Hospitals since July 1, 1945,⁶ consisting of persons having achlorhydria or hypochlorhydria, pernicious anemia, a family

history of gastric carcinoma, a hemoglobin level of 11.0 grams or less, or occult blood in the stools. In this group, Ruzicka reports the following results:

Age	Number of Persons	Number of Gastric Carcinoma	Polyps	Gastric Carcinoma and Polyps: Rate per 1000
Under 65	764	0	17	22.2
65 and over	827	8	19	32.6

These results were attained as a result of 1,967 examinations made on 1,591 persons. They confirm both the feasibility and desirability of mass gastric surveys, even with standard methods, in selected population groups.

Moreover, Dr. Moore, in his discussion of mass gastric surveys, for some reason does not mention the photofluorographic method, which eliminates the element of overexposure for the roentgenologist and greatly increases the number of examinations which can be made rapidly by a relatively small number of roentgenologists and technicians.⁷

The Johns Hopkins groups have shown (unpublished data on 4,000 examinations) that photofluorographic examinations of persons coming to their outpatient clinics detect approximately 97 per cent of all gastric pathology and all cases of gastric cancer, which would have been discovered by the standard roentgenological procedures. This examination is done without roentgenoscopy, by trained roentgen-ray technicians, without completely disrobing the patient, with a series of six films taken over a five minute period, with the aid of the usual opaque medium. By this procedure the technician does the roentgenography and the roentgenologists do the interpretation on screening films and follow-up with complete examinations on persons with suspicious findings. There are enough radiologists in the country to carry out such a plan on the adult population over a reasonable period of time. The results would

⁴ Rigler, L. G., and Kaplan, H. S. Pernicious anemia and tumors of stomach. *J. Nat. Cancer Inst.*, 1947, 7, 327-332.

⁵ Parenthetically, we wonder at the lack of reference to gastric polyps in Dr. Moore's discussion of mass gastric surveys, since (a) the precancerous nature of gastric polyps is generally recognized and (b) their prevalence is considerably greater than that of gastric carcinoma, so that the value of mass surveys in detecting significant pathology of the stomach is correspondingly increased.

⁶ Bulletin of the University of Minnesota Hospitals and Minnesota Medical Foundation XX, No. 31, June 10, 1949, pp. 66-667. (The table presented above is rearranged from data presented in this paper.)

⁷ Roach, J. F., Sloan, R. D., and Morgan, R. H. Detection of gastric carcinoma by photofluorographic methods. Parts I and II. *AM. J. ROENTGENOL. & RAD. THERAPY*, Feb., 1949, 61, 183-187; 188-194.

be more early operable gastric cancers and fewer late inoperable cases; more living cancer patients and fewer dead ones (even though their premortal diagnosis was correct and complete); more time well spent on interesting cases for the busy radiologist and less wasted time on normal persons.

The results already obtained by the Johns Hopkins group, as reported at the June, 1949, meeting of the American Medical Association, Section on Radiology, are pertinent to the objections raised by Dr. Moore, that roentgenologic gastric surveys would not detect early lesions and that they would have to be performed on the same individuals at too short intervals, such as three months, to be practicable (points 4 and 5 above). Out of 27 cases of gastric carcinoma detected by the photofluorographic method and confirmed by the standard roentgenographic procedures, 8 cases had either no symptoms or such mild symptoms that it has not been possible to persuade these patients to undergo operation. They are being followed and re-examined at frequent intervals, so that valuable objective data on the course of early asymptomatic gastric carcinoma are being collected. These observations, of course, will have to be extended, but they suggest that the course of gastric carcinoma in its early asymptomatic stage is sufficiently slow so that periodic examinations at intervals greater than a year may be sufficient to detect most lesions at this stage.

The experience already at hand thus indicates that none of the objections raised by Dr. Moore against mass gastric surveys is valid, either for the standard roentgen diagnostic procedure when applied to selected population groups, or for the photofluorographic method, to be applied to larger groups.

Dr. Moore also gives the opinion that mass chest roentgenologic surveys have "glaring defects" because more cases are found than there are facilities with which to provide care. Surely this is not a defect

of the diagnostic method. The most effective way to stimulate the community to provide adequate facilities is to show the need, by finding the cases. In some communities, such as Minneapolis, Seattle, and Niagara Falls, mass chest surveys have reached over 75 per cent of the adult population. Even if full facilities for sanatorium care of all newly discovered cases are not available, the individuals concerned have been warned of the presence of tuberculosis and they, their physicians and the local health department have been enabled to take steps to prevent extension of the disease or its spread to other persons. Dr. Moore goes on to cite, as an example of a successful tuberculosis control program without mass chest roentgenologic surveys, the eradication of tuberculosis in cattle. One need only remember that this was done simply by mass tuberculin testing of cattle and mass slaughtering of those found positive, to judge whether this program could be considered as a substitute for mass chest roentgenograms, in the control of tuberculosis in human beings.

On the basis of the importance of gastric cancer as a cause of disability and death, and the already demonstrated feasibility and practicability of mass gastric surveys, especially with the photofluorographic technique, in the early detection of gastric cancer, we feel that none of the objections thus far raised against this method is sufficiently valid to justify interruption of efforts to improve, expand and, eventually, apply to the entire adult population, this case-finding procedure for early gastric cancer.

State of New York
Department of Health
Albany, N. Y.

HERMAN E. HILLEBOE, M.D.
Commissioner of Health

MORTON L. LEVIN, M.D.
Assistant Commissioner for Medical Services

PAUL R. GERHARDT, M.D.
Director, Bureau of Cancer Control

THE JOURNAL OF THE FACULTY OF RADIOLOGISTS

There has just arrived at the editorial desk, Volume 1, Number 1, of *The Journal of the Faculty of Radiologists*. This latest journal dealing with radiological problems is the official organ of the Faculty of Radiologists of London, England, and is published quarterly in July, October, January and April by John Wright and Sons, Ltd. The subscription price to non-members is £2.2s. a year.

The Faculty of Radiologists feels that the time is opportune for the publication of a journal devoted to clinical radiology, and sensing the need of such a publication they have just issued their first number. The Faculty of Radiologists is recognized by the Government as the body representing medical radiology and as a result of this recognition the Faculty of Radiologists feels that it is imperative that it should have some official organ to make public its activities.

If the content of their first volume is a forecast of what is to follow, the journal should meet with a ready acceptance throughout the radiological world. Their first issue deals with "Cerebral Tumours"; an interesting paper on "A Comparison of the Radiological and Pathological Changes

in Coalworkers' Pneumoconiosis"; "The Classification of Radiographic Appearances in Coalminers' Pneumoconiosis"; "The Place of Radiotherapy in the Treatment of Chronic Lymphoid Leukaemia"; "Radiotherapeutic Treatment of Leukaemia"; "The Doctor-Patient Relationship in the Treatment of Cancer."

The radiological world welcomes with pleasure this latest publication by the Faculty of Radiologists. The distinguished members of that organization have worldwide reputations and a journal issued under their aegis should be among the finest.

WISCONSIN RADIOLOGICAL SOCIETY

A new society of radiologists of the state of Wisconsin was organized at a meeting held in Madison, Wisconsin, on August 26, 1949. The organization is called the Wisconsin Radiological Society and has thirty-five charter members, all of whom are diplomates of the American Board of Radiology. The following officers were elected: *President*, Dr. Lawrence V. Littig, Madison; *President Elect*, Dr. Ernst A. Pohle, Madison; *Secretary Treasurer*, Dr. Irving I. Cowan, Milwaukee; *Board of Censors*, Dr. S. Richard Beatty, Neenah, Dr. J. Edwin Habbe, Milwaukee, and Dr. Victor J. Bruder, La Crosse.



BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

NEOPLASMS OF BONE AND RELATED CONDITIONS: THEIR ETIOLOGY, PATHOGENESIS, DIAGNOSIS, AND TREATMENT. By Bradley L. Coley, M.D., Attending Surgeon, Bone Tumor Department, Memorial Hospital for Cancer and Allied Diseases; Assistant Professor of Clinical Surgery, Cornell. Cloth. Price, \$17.50. Pp. 765, with 622 illustrations and 53 tables. New York: Paul B. Hoeber, Inc., 1949.

In this book the author has compiled a very comprehensive study of neoplasms of bone based on his large experience which includes at least twenty-five years spent in the Bone Tumor Department of Memorial Hospital. This is demonstrated by the titles of the eleven sections into which the book is divided.

Section One includes the classification of tumors, etiology, diagnostic survey in suspected cases of bone tumor, differential diagnosis, and the last chapter is a discussion of the role played by blood chemistry in bone tumors by Helen Q. Woodard, M.D. This is well worth special mention. Section Two includes benign tumors and tumorlike lesions of bone. Then follow, primary malignant tumors of bone, tumors involving bone by extension, metastatic tumors involving bone, tumors of bone in special localities, surgical treatment, radiation therapy, constitutional therapy, lesions of the skeletal system that may simulate neoplasms of bone and a final section entitled Miscellaneous which includes pathologic fractures, medicolegal aspects of trauma in tumors of bone, and the experimental production of bone sarcoma.

The illustrations, especially the roentgenograms of the various lesions, are clearly reproduced and are in sufficient number to show the wide variations in the appearance of some types of lesions. Not only the common types but also the unusual and the more rare types of tumors are shown.

In the preface Coley states the purpose of the book is to present the subject in a form that will be of value not only to the oncologist but also to the orthopedist, the radiologist, the general surgeon and the general practitioner,

and in this effort he has been successful. Objection may be raised that comparatively little emphasis is placed on the microscopic pathology of the various tumors but this is atoned for by greater emphasis on the clinical aspects, the difficulties of early diagnosis, the differential diagnosis, various therapeutic indications and technics, and the results of treatment.

Coley believes it is no exaggeration to say that nearly half of the cases of osteogenic sarcoma have the disease in detectable form for more than six months before a correct diagnosis is made. One can only speculate on the favorable effect on survival rates were this period of time cut in half. This, Coley believes, could be accomplished by a keener realization of the significance of the early symptoms and a wider tendency to insist upon early roentgenographic examination when these symptoms are present.

The section on radiation therapy is a fair and just estimate of its value and includes discussion of the physical factors involved in the irradiation of tumors of bone, the effect of radiation on bone, indications for roentgen therapy, methods and dosage, effect of radiation on neoplasms of bone and the effect of radium poisoning on skeletal tissue.

The bibliography is ample and the index includes one of personal names in addition to the one of subjects. The format of the book is excellent. It should be in the library of every radiologist. Not only is it valuable for the wide coverage of the subject, but also for the inclusion of the newer types of lesions described in the literature of the past decade, now generally accepted as entities.

R. S. BROMER, M. D.

MANAGEMENT OF COMMON GASTRO-INTESTINAL DISEASES. Edited by Thomas A. Johnson. The American Practitioner Series. Cloth. Price, \$7.00. Pp. 280, with 16 illustrations. Philadelphia: J. B. Lippincott Co., 1948.

This book of 280 pages, written by twenty-one contributors, contains condensed and

authoritative statements relating to the commonly encountered gastrointestinal diseases. The authors and their topics are well selected, and the subjects covered adequately. Naturally in such a large field, there is ample opportunity for divergent points of view, but in general it can be said that the opinions expressed are sound and mature.

In a number of the chapters the all important influence of emotional tension on gastrointestinal symptomatology is properly stressed. The discussion of Edward Weiss on "Psychosomatic Aspects of Gastro-Intestinal Disorders" should be read and assimilated by all physicians who practice medicine, regardless of whether their interest is limited to the field of gastroenterology. His ability to discuss the subject clearly and emphasize important points by apt phraseology is illustrated by the following: "The abdomen is, indeed, the sounding board of the emotions," "the chronic gastro-intestinal invalid with a battle-scarred abdomen of polysurgical addition"; and "the unconscious will remain sick." With reference to unnecessary abdominal operations he says: "A willing and eager patient who derives a certain satisfaction from being hospitalized and operated upon and a surgeon who is ever ready to wield a knife, is a very unfortunate combination."

The chapter on "The Diagnosis and Treatment of Irritable Colon" by E. N. Collins is one of importance as it deals with a common disorder with which every physician should be thoroughly familiar. The author emphasizes that the irritable colon (unstable colon, functional colon, mucous colitis, or spastic bowel) is a frequent cause of abdominal complaints and one of the most neglected entities in the practice of medicine. Of special importance is emphasis on the tendency to perform unnecessary operations on such patients, and he cites as evidence a table which indicates that almost one-third of such patients were operated upon without relief of symptoms. It is of interest to note that of 204 patients with irritable bowel, the appendix had been removed in 163.

The chapter on "The Diagnosis of Pancreatic Disease" by Thomas A. Johnson deserves special commendation. The subject is covered adequately and is doubtless based on a wide experience in this field. He emphasizes, in speaking of carcinoma of the pancreas, that diagnostic accuracy is not great, especially when jaundice is absent. The major role of this condition as a basis for obscure abdominal

pain should be kept in mind. Among other diagnostic measures which he advocates is the roentgenological study of the pancreas through changes produced in the adjacent segments of the gastrointestinal tract which yields valuable information and should be employed more extensively.

The diagnosis and management of distal ulcerative colitis is discussed by Johnson in 14 pages. When the controversial nature of many of the aspects of this disease is considered, it must be agreed that he has condensed them all satisfactorily into a relatively small space. He considers all of the forms of treatment which have been advocated in a sensible fashion. Some will dissent, however, from his opinion that "When it becomes apparent that the patient is not coping with the disease, and before he becomes a poor surgical risk, ileostomy becomes a procedure of choice." The operative procedure suggested is probably correct but the difficulty arises in deciding *when* such an operation is propitious.

The book is to be recommended as a well written, reliable collection of articles dealing with the common gastrointestinal diseases, which covers the field briefly but adequately.

CYRUS C. STURGIS, M.D.

HANDBOOK OF DISEASES OF THE SKIN. By Richard L. Sutton, M.D., Emeritus Professor of Dermatology and Syphilology, University of Kansas Medical School, and Richard L. Sutton, Jr., M.D., Associate Professor of Dermatology and Syphilology, University of Kansas Medical School. Cloth. Price, \$12.50. Pp. 749, with 1057 illustrations. St. Louis: C. V. Mosby Co., 1949.

The Suttons are well known authors of several textbooks of dermatology, including a Synopsis and an Introduction to Dermatology which is in its fourth edition. The present volume is more complete than the former and less voluminous than the latter and is aimed at supplying a textbook for the needs of the student and general practitioner. It follows in general the usual development of the subject with many excellent illustrations and should serve its purpose well as a standard textbook of dermatology.

As far as the radiologist is concerned, one is struck as with all textbooks of dermatology at the dearth of information on roentgen rays and other forms of radiant therapy despite

the frequency with which these therapies are recommended and utilized by dermatologists. A second criticism which may be minor but which was disconcerting to the present reviewer is the frequent occurrence of statements such as the following paragraph on the use of sex hormones:

"Sex hormones, including male, female, and gonadotropic, have utility in some conditions. They are potent substances . . . and can cause trouble. Estrogenic substances in correct dosage may help rosacea and some cases of acne." However, this form of empiric therapy is generally recognized as a defect of dermatology and the present text cannot be held accountable for a failing general to the subject.

ARTHUR GROLLMAN, M.D.

AN INTRODUCTION TO GASTRO-ENTEROLOGY. By

Walter C. Alvarez, Professor of Medicine, University of Minnesota, The Mayo Foundation, and a Senior Consultant in the Division of Medicine, The Mayo Clinic. Fourth edition, revised and enlarged. Cloth. Price, \$12.50. Pp. 903, with 269 illustrations. New York: Paul B. Hoeber, Inc., 1948.

An interesting fact which has gradually been lost sight of in the prefaces to the subsequent editions is that the first edition of this work consisted of the elaborated first annual Caldwell Lecture, established by the American Roentgen Ray Society in 1920 in honor of Eugene Wilson Caldwell, one of the most beloved and respected of the early American radiologists.

The work has grown from a relatively small volume in the first edition to the present fourth edition of nine hundred pages. The older members of our specialty may remember a similar book by H. Roger, famous French savant, which in the early years of this century served as a textbook for students beginning the study of internal medicine. It was a delightful and most readable work. For the student of today, we have its counterpart for the digestive tract in this excellent work by Alvarez.

The author's writings have a characteristic appeal for the reader which keeps up his interest in each paragraph. The discussion concerns principally the motor function of the digestive tube and discusses just about every possible phase of its motor functions.

The new additions to the text include chapters on the pylorus, the nerves running to the bowel, the nerves of the gallbladder, the func-

tions of the colon, flatulence, the electroenterogram, technical methods and apparatus, and finally, because of the present-day interest in the Dragstedt operation, much information has been included on the effects of vagotomy in man.

JAMES T. CASE, M.D.

BILHARZIAL CANCER: RADIOLOGICAL DIAGNOSIS AND TREATMENT. By Mahmoud Ahmed Afifi, M.B., Ch.B. (Cairo), M.R.C.S. (England), L.R.C.P. (London), D.M.R.E. (Cambridge). Former Director of the Radiological and Electro-therapeutic Departments of the Egyptian Government Hospital, Alexandria. Cloth. Price, 16/. Pp. 111, with 60 illustrations. London: H. K. Lewis & Co., Ltd., 1948.

This condition is found mostly in Egypt and its environs. The monograph will therefore be limited in its appeal. The reviewer found the text absorbing because of the unusual ramifications of the disease.

A peculiar "water wash" appearance was observed in roentgenograms of the abdomen attributable to the calcium contained in the bilharzial ova. The bladder, prostate, and rectum seemed unusually susceptible to superimposed carcinoma of the scirrhous type.

Treatment was no more effective in these cancers than it is in other similar forms of malignant disease.

The book is easy to read and the paper, illustrations and type are good.

PHILIP J. HODES, M.D.

HISTOPATHOLOGY OF IRRADIATION FROM EXTERNAL AND INTERNAL SOURCES. (National Nuclear Energy Series IV—22 I.) Edited by William Bloom, M.D., Professor of Anatomy, Department of Anatomy and Institute of Radiobiology and Biophysics, University of Chicago. Cloth. Price, \$8.00. Pp. 808, with numerous illustrations. New York: McGraw-Hill Book Co., Inc., 1948.

Histopathology of Irradiation from External and Internal Sources is an 808 page volume, including appendix, bibliography, and index. It is volume 22 I of Division IV of the Atomic Energy Publications of sixty volumes which are to cover the declassified work of eight separate projects. The Plutonium Project is Division IV.

The material reported consists of a summary of the work performed from 1943-1945 by the Histological Group of the Health Division, Metallurgical Laboratory, University of Chicago. The histopathological effects of whole body irradiation in animals by internal and external sources are recorded.

Roentgen rays, gamma rays, beta rays, and fast and slow neutrons were applied externally, while alpha-, beta-, and gamma-emitting substances were introduced into animals from a variety of sources. Most of the work was cytological rather than histopathological study. Hematoxylin-eosin-azure II staining technique was utilized. Dosage employed was normally the LD₅₀/30 days. Most of the animals utilized were mice and rats, with fewer rabbits and guinea pigs.

Histopathological studies reported refer to

body cells, skin, bone, bone marrow, spleen, lymph node and intestinal lymphatic tissue, thymus, gastrointestinal tract and accessory structures, testis, ovary, kidney, lung, vascular system, adrenal, and the nervous system. Changes in most tissues are those previously reported, although only the acute effects of irradiation in tissue were observed.

This publication adds detail in the form of knowledge of effects of a variety of radioactive compounds but does not supplement the sum total of knowledge of the histopathologic changes attributable to irradiation. As a reference work for the experimentalist in the field of radiology the publication is of value, but it is impractical for the pathologist or clinician as it was prepared by workers with an inadequate background in histopathology.

A. JAMES FRENCH, M. D.



ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

- Head*
- McGREGOR, M.: Significance of certain measurements of the skull in the diagnosis of basilar impression..... 584
- Neck and Chest*
- HAIGHT, C.: Congenital tracheo-esophageal fistulas without esophageal atresia..... 584
- HUEBER, F., and GAJA, C.: Stratigraphy in the diagnosis of less common diseases of the larynx..... 584
- KINSELLA, T. J., MORSE, R. W., and HERTZOG, A. J.: Spontaneous rupture of esophagus. 584
- ROEMMICH, W., WEBER, F. J., *et al.*: Preliminary report on a community-wide chest x-ray survey at Minneapolis, Minnesota. 585
- CASTALDI, L.: Serialographic investigation in roentgenological examination of respiratory apparatus..... 585
- GIANNARDI, G.: Study of roentgenographic anatomy of normal thymus with pneumomediastinum..... 586
- ADAMS, W. E.: Differential diagnosis and treatment of congenital cystic malformation of the lung..... 587
- WALKER, J. M., TAGGART, W. B., and STATON, H. J.: Tension type of congenital pulmonary cyst..... 587
- ORTMAYER, M.: Cystitis emphysematosa..... 587
- SMITH, C. E., BEARD, R. R., and SAITO, M. T.: Pathogenesis of coccidioidomycosis with special reference to pulmonary cavitation. 588
- MACKIE, T. T.: Parasitic infection of the lung. 588
- MACHLE, W.: Pathogenesis of industrial pulmonary disease..... 589
- SHAVER, C. G.: Further observations of lung changes associated with manufacture of alumina abrasives..... 589
- WILSON, S. A.: Delayed chemical pneumonitis or diffuse granulomatosis of lung due to beryllium..... 590
- BERGMANN, M., SHATZ, B. A., and FLANCE, I. J.: Apical pulmonary carcinoma and tuberculosis..... 590
- GARDELLA, G.: Alterations in thoracic cage in diagnosis of lung tumors..... 590
- CRIMM, P. D.: Spontaneous collapse..... 590
- BLADES, B.: Empyema..... 591
- CARSON, M. J., *et al.*: Diagnosis of pulmonary stenosis by angiocardiology..... 591
- Abdomen*
- CAVE, P.: Stomach in femoral hernia..... 591
- BRALOW, S. P., SCHEINBERG, S., and NECHELES, H.: Peptic ulcer and pregnancy..... 592
- BASSLER, A., and PETERS, A. G.: Distinctions between gastric sarcoma and carcinoma.. 592
- CONTI, J. G., JR., FOLTZ, T. P., and STEVENS, G. A.: Surgical and roentgenologic aspects of duodenal diverticula..... 593
- REID, D. R. K.: Argentaffinoma of the gastrointestinal tract..... 593
- GLASS, W. H.: Small intestinal deficiency pattern..... 593
- DELARIO, A. J.: X-ray examination of the vermiform appendix..... 594
- GROSS, R. E., and WARE, P. F.: Intussusception in childhood..... 594
- RAVITCH, M. M., and McCUNE, R. M.: Reduction of intussusception by barium enema. 594
- MANTOVANI, D., and STRANIERI, R.: Case of double gallbladder..... 595
- COMFORT, M. W., GRAY, H. K., and WILSON, J. M.: The silent gallstone..... 595
- DOUBILET, H., and MULHOLLAND, J. H.: Recurrent acute pancreatitis..... 595
- Gynecology and Obstetrics*
- FOOTE, F. W., JR., and STEWART, F. W.: Anatomical distribution of intraepithelial epidermoid carcinomas of cervix..... 596
- SOLOMON, E. P., and LOVEMAN, A. B.: Chancre and carcinoma of cervix..... 596
- COHEN, M., and CRAVOTTA, C. A.: Sarcoma of uterus..... 596
- Genitourinary System*
- SAMUEL, E.: Calcification in suprarenal neoplasms..... 596
- BRAASCH, W. F., GREENE, L. F., and GOYANNA, R.: Renal ptosis and its treatment. 597
- Low, H. T., and COAKLEY, H. E.: Leukoplakia of renal pelvis..... 597

- CULP, O. S., and HARTMAN, F. W.: Mesoblastic nephroma in adults..... 597
 ARNHEIM, F. K.: Carcinoma of the prostate.. 598

Nervous System

- SMITH, C. A.: Paraganglioma (pleochromocytoma)..... 598

Skeletal System

- ELLIS, V. H.: Squamous-cell carcinoma of the nail bed..... 599
 EDMONDS, H. W., COE, H. E., and TABRAH, F. L.: Bone formation in skin and muscle. 599
 BRAILSFORD, J. F.: Ossifying hematomata and other simple lesions mistaken for sarcomata..... 599
 PONSETI, I.: Bone lesions in eosinophilic granuloma, Hand-Schüller-Christian disease and Letterer-Siwe disease..... 600
 WILSON, J. C., JR.: Streptomycin in the treatment of chronic infections of bone..... 601
 WARRICK, C. K.: Posterior dislocation of the shoulder joint..... 601
 KHOO, F. Y., and KUO, C. L.: Unusual anomaly of inferior portion of the scapula.... 601
 VITT, R. J.: Dislocation of head of the fibula.. 602
 FAIRBANK, T. J.: Knee joint changes after meniscectomy..... 602
 LEVEUF, J.: Results of open reduction of "true" congenital luxation of the hip..... 602
 LE MESURIER, A. B.: Developmental coxa vara..... 603
 VITERBO, F.: Roentgenological contribution to the study of vertebral echinococcus cysts. 604
 LISCHI, G.: Two cases of primary sclerosis of a solitary vertebra..... 604
 ROCHE, M. B.: Bilateral fracture of the pars interarticularis of a lumbar neural arch... 605
 CALDWELL, G. A., and SHEPPARD, W. B.: Criteria for spine fusion following removal of protruded nucleus pulposus..... 605
 DU TOIT, J. G., and FAINSINGER, M. H.: Spinal extradural cysts..... 605
 ZADEK, I., and GOLD, A. M.: Accessory tarsal scaphoid..... 606
 HARRIS, R. I., and BEATH, T.: Etiology of peroneal spastic flat foot..... 606
 FAIRBANK, H. A. T.: Dyschondroplasia..... 607
 SHERMAN, MARY S.: Estrogens and bone formation in human female..... 608
 VANDEMARK, W. E., and PAGE, M. A.: Massive hyperplasia of bone following fractures of osteogenesis imperfecta..... 608

General

- ARCHER, V. W., COOPER, G., JR., and ADAIR, N.: Symptoms masked or modified by chemotherapy..... 608
 PESKIN, A. R.: Increased sugar tolerance as a factor in the production of a symptom

- complex simulating peptic ulcer, neuro-circulatory asthenia and psychoneurosis.. 609
 BRODSKY, E.: Income-sharing formula..... 609

ROENTGEN AND RADIUM THERAPY

- TRUSLER, H. M., and BAUER, T. B.: Keloids and hypertrophic scars..... 609
 KIMBROUGH, R. A., and MUCKLE, C. W.: Treatment of carcinoma of the cervix.... 610
 MACFARLAND, CATHARINE, STURGIS, MARGARET C., and FETTERMAN, FAITH S.: Control of cancer of the uterus..... 610
 COSTLOW, W. E.: Management of Stage I carcinoma of cervix uteri..... 610
 HALL, J. W., and FRIEDMAN, M.: Histologic changes in squamous-cell carcinoma of the mouth and oropharynx produced by fractionated external roentgen irradiation..... 611
 HAMANN, ANNA: External irradiation with roentgen rays and radium in treatment of human leukemias, lymphomas, and allied disorders of hemopoietic system... 612
 SPURR, C. L., SMITH, T. R., and JACOBSON, L. O.: Chemotherapy in human lymphomas, leukemias, and allied disorders of hemopoietic system..... 612
 KARNOFSKY, D. A.: Chemotherapy of neoplastic disease. I..... 613
 KARNOFSKY, D. A.: Chemotherapy of neoplastic disease. II..... 613
 KARNOFSKY, D. A.: Chemotherapy of neoplastic disease. III..... 613
 DONNELLEY, G. C., and BAULD, A. G.: Aspects in treatment of vulvar and cervical carcinoma..... 613
 SPEERT, H., and PEIGHTAL, T. C.: Evaluation of adjunctive radiotherapy in surgical treatment of endometrial carcinoma..... 614
 MUNNELL, E. W., and BRUNSCHWIG, A.: Five year end-results of irradiation therapy of cancer of cervix uteri at Memorial Hospital..... 614
 KARDASH, T.: Sarcoma of the uterus..... 615
 SAUER, H. R., MACMANUS, J. E., and BLICK, M. S.: Primary malignant neoplasms of vesicovaginal septum..... 615
 ORMOND, J. K., and BEST, J. W.: Prognosis of testicular tumors..... 615
 LEUCUTIA, T., EVANS, W. A., and COOK, J. C.: Radiation therapy of malignant tumors of the testis..... 616
 HAWLEY, S. J.: Rotation therapy..... 616
 KAPLAN, I. I., and ETKIN, S. I.: Treatment of deep-seated malignant tumors with multiple port technic simulating rotation therapy..... 616

ROENTGEN DIAGNOSIS

HEAD

McGREGOR, M. The significance of certain measurements of the skull in the diagnosis of basilar impression. *Brit. J. Radiol.*, April, 1948, 21, 171-181.

Primary basilar impression is a congenital anomaly resulting in upward dislocation of the upper cervical segments in relation to the cranium. Secondary basilar impression is a similar condition based on osteoporosis, delayed or faulty ossification, bone destruction or trauma. The diagnosis can be established only by roentgen methods.

The best single index of basilar impression is Chamberlain's line, from the dorsal tip of the foramen magnum to the dorsal margin of the hard palate. Projection of the odontoid above this is abnormal. A more satisfactory modification of this has as its posterior extremity the most caudal point of the occipital curve.

The basal angle is included between lines connecting the center of the pituitary fossa with the mesion and the anterior lip of the foramen magnum. The normal value is $135^\circ \pm 10^\circ$ degrees. This has been thought of as a good index of basilar impression but it is actually inconstant, and basilar impression may exist with a normal basal angle. On the other hand, a small number of patients have been observed and comparison made of their measurements and symptoms, and it is suspected that the basal angle is a good criterion for prediction of symptoms. In advanced basilar impression with a normal basal angle there are no symptoms; with an increased angle, symptoms are to be expected.

The author suggests that platybasia be restricted to an increased basal angle and upward dislocation of the odontoid be described as basilar impression.—*E. F. Lang, M.D.*

NECK AND CHEST

HAIGHT, CAMERON. Congenital tracheo-esophageal fistulas without esophageal atresia. *J. Thoracic Surg.*, Oct., 1948, 17, 600-612.

Congenital tracheo-esophageal fistula without atresia of the esophagus is rare, having been found in approximately 3 per cent of a series of 65 cases of anomalies of the esophagus observed by the author. The symptoms are choking and coughing coincident with the ingestion of feedings, particularly with the ingestion of liquids.

The roentgen examination should be done with the patient in the prone position. This position causes the fistula to be dependent in its relation to the esophagus, thereby allowing the iodized oil to enter the trachea by gravitation. A suggestive but not diagnostic sign is the presence of an unusually large amount of air in the stomach or intestines. The gastric dilatation becomes evident when the infant cries or strains, appearing to be due to an increase of intratracheal pressure in the presence of a closed glottis and the expulsion of air into the esophagus and stomach.

Tracheoscopy, esophagoscopy, or both, should be used in cases in which the anomaly is suspected. Because of its rarity and past difficulties in establishing the diagnosis, operative correction has been employed in only one previously reported patient. The author reports the case of a four year old child in whom the fistula was corrected.—*Frederick M. Reis, M.D.*

HUEBER, FRANCO, and GAJA, CLEMENTE. L'indagine stratigrafica nella diagnostica di malattie poco comuni dello scheletro laringeo. (Stratigraphy in the diagnosis of less common diseases of the larynx.) *Radiol. med.*, March, 1948, 34, 129-138.

The authors are of the opinion that laminagraphy of the larynx in the anteroposterior projection is a valuable adjunct in the study of the less common diseases of this organ. Admitting that the cartilaginous elements of the larynx per se are not visualized, it is indicated that lesions of these elements reveal themselves indirectly by disturbing or altering the normal soft tissue outlines of the larynx as seen in stratographic examinations. Three unusual case histories with roentgenograms are included. These include luxation of the arytenoid cartilage, arthritis of the cricoarytenoid cartilages and dislocation of the thyroid cartilage.—*Anthony C. Galluccio, M.D.*

KINSELLA, THOMAS J., MORSE, RUSSELL W., and HERTZOG, AMBROSE J. Spontaneous rupture of the esophagus. *J. Thoracic Surg.*, Oct., 1948, 17, 613-631.

Spontaneous rupture of the esophagus is a grave lesion especially because the origin of the difficulty is almost never suspected as there is usually nothing to suggest an esophageal lesion, and the patient is frequently in such desperate condition as to be unable to tolerate any surgical procedure. The characteristic

clinical picture is described and the differential diagnosis discussed. The most frequent misdiagnosis encountered has been that of ruptured peptic ulcer. The mediastinal emphysema, which is present in more than 60 per cent of the reported cases, should help to make the correct diagnosis.

The earliest findings on the roentgenograms are the presence of emphysema in the mediastinum, localized at first, later more extensive, involving the whole mediastinum, and eventually fanning out as subcutaneous emphysema in the cervical region.

Other important roentgenologic findings are: the demonstration of a fluid level in the mediastinum, pneumothorax on one or both sides, most frequently on the left, and a fluid level within this pneumothorax pocket. The absence of subphrenic air or gas helps to rule out perforation of a subphrenic hollow viscus. If further evidence is required, it may be obtained by orally administered barium or iodized oil. The iodized oil is easier to remove from the surgical field subsequently, but the risk of iodism must be remembered. Aspiration of characteristic fluid from the pleural cavity confirms the diagnosis.

Spontaneous perforation of the esophagus may occur from pressure of vomiting through a normal structure, or from erosion, ulceration and dilatation. The treatment is discussed and 5 cases of spontaneous perforation of the esophagus presented by the authors.—*Frederick M. Reis, M.D.*

ROEMMICH, WILLIAM, WEBER, FRANCIS J., HILL, FRANK J., and AMOS, LUCILLE. Preliminary report on a community-wide chest x-ray survey at Minneapolis, Minnesota. *Pub. Health Rep.*, Oct. 1, 1948, 63, 1285-1290.

During an intensified chest roentgen survey in Minneapolis, Minnesota, 306,020 examinations were made using 70 mm. roentgen units. Of the films 1.5 per cent were excluded because of unsatisfactory quality. Of the examinations 96.6 per cent were "negative" and 3.4 per cent required further study with 14 by 17 inch films and clinical investigation. Of the 3.4 per cent, 2 per cent were suspected tuberculous and 1.4 per cent were suspected other chest diseases. Eight hundred forty-one "cardiacs" were not investigated by large films.

Appointments were given 9,236 for 14 by 17 inch chest films and within five months

8,333 had responded. Of this group, 28 per cent were regarded as essentially negative, 46.2 per cent were suspected of having tuberculosis and 25.8 per cent were suspected of having other diseases. Utilizing the 6,002 cases remaining after excluding the 2,331 negative chest films, the authors found 64.1 per cent (3,850 cases) suspected tuberculosis and 35.9 per cent suspected other pathology. All cases considered "positive" on 14 by 17 inch film findings were referred to private physicians (70 per cent) or public health center clinic (30 per cent). Checked against the local tuberculosis case registry, only 9.2 per cent (353 persons) were found to be registered. At the time of making this report, 1,500 returns had been made out of the 6,000 referrals. Of the 1,500 returns, 648 (43.2 per cent) were diagnosed as positive for tuberculosis; 428 by bacteriological study, and 220 not examined bacteriologically. Of the 648 cases 98 were found to be active and of these only 9 were registered; 6 were on the active list and 3 on the inactive list. An additional 9 cases with active tuberculosis admitted history of disease but were not known to the local authorities.

Thus 80 new cases (with complete returns not in on the entire investigation) of active pulmonary tuberculosis were found by mass survey; 25 had neither contact nor symptoms and could have been found only by mass investigation, such as that conducted, or by fluoroscopic or tuberculin testing methods. Of these cases 55 had symptoms presumably related to their tuberculosis. Analyzing still further, only 3 of the 80 new cases discovered could have been found through contact examinations.

Within six months of completion of the actual mass survey (making of the 70 mm. films) 55 of the 98 persons with active tuberculosis had entered a sanatorium; of these 30.9 per cent were minimal, 56.4 per cent moderately advanced, and 12.7 per cent far advanced. No one was excluded from sanatorium care on basis of bed shortage.—*Angus K. Wilson, M.D.*

CASTALDI, LUIGI. L'indagine seriografica nell'esplorazione radiologica dell'apparato respiratorio. (Serialographic investigation in the roentgenological examination of the respiratory apparatus.) *Radiol. med.*, Feb., 1948, 34, 65-74.

The author discusses the limitations of both the roentgenoscopic and the roentgenographic methods of investigation of the respiratory

tract and stresses that the two methods should be complementary.

Roentgenoscopy permits the examination of the functioning lung in all and any projections but offers a "twilight" visualization with poor detail.

Roentgenography gives clearer definition of structural detail but is static. It only allows standard positions. Shadows visible in other projections and fleeting images such as seen in the course of contrast studies during fluoroscopy may not be registered on the film.

The serialographic examination of the respiratory tract under fluoroscopic control retains the advantages of both methods and eliminates their disadvantages.

The author mentions the widespread use of spot film devices in the study of the gastrointestinal tract and attributes the first adoption of this method to Busi in 1913.

Perhaps the greatest importance of this method is that the examination is under direct control of the clinician rather than the passive one of a technician.

Principal applications.

1. Comparative studies of doubtful images of the pulmonary markings and of poorly visualized cavities or pseudo-cavities. The differentiation between true infiltrations and normal vascular pulmonary tracers can be facilitated since the former will give more or less constant shadows in the various projections available.

In the study of cavities the method of choice is stratigraphy. The serialographic examination is of great aid since the region can be studied in all projections.

2. Visualization of pleural adhesions during pneumothorax. Accurate determination of the number, form, type, and thickness of pleural bands can be obtained and is of great value preceding a resection by the Jacobaeus operation.

3. Bronchography of limited areas. Studies of specific portions of the bronchial tree following instillation of the iodized oil under fluoroscopic control is possible.

4. Roentgenologic control of treatment by the method of endocavitary aspiration described by Monaldi.

This can be practiced directly or by contrast study. The cavity can be filled under roentgenoscopic control and detailed information can be obtained as to its size, shape, drainage,

bronchial communications and fistulous tracts.
—Anthony A. Blasi, M.D.

GIANNARDI, GOFFREDO. Saggio di anatomia radiografica del timo normale col penumomediastino. (Study of roentgenographic anatomy of the normal thymus with pneumomediastinum.) *Radiol. med.*, Jan., 1948, 34, 27-41.

The author points to the difficulty in the accurate evaluation of thymic enlargement by roentgenography.

The determination of the size of the thymus has been estimated by variations in the normal size and shape of the superior mediastinum in the frontal projection, and in changes in the retrosternal space in the lateral projection.

A factor of error is introduced by the great normal variations in size and shape of the thymus. In the evaluation of the appearance of the superior mediastinum certain factors must be considered: (1) position of patient; (2) age of patient; (3) habitus; (4) physical state (respiratory phase, etc.).

The possibility that alteration of the size and shape of the mediastinum may be due to enlargement of structures other than the thymus and to the presence of pathological processes, must be recognized.

The author presents a series of 11 cases in which pneumomediastinum was done on autopsy material in an attempt to establish roentgenographic criteria for the normal thymus.

Condorelli's technique was followed. The technique for the production of the penumomediastinum is not described.

The frontal projection following pneumomediastinum did not give significant findings. In the lateral projection, the retrosternal space was clearly demonstrated.

The posterior margin of the retrosternal space is formed by the ascending aorta, the pulmonary conus and the anterior surface of the right ventricle.

In a preliminary examination, without contrast material, the normal thymus was never definitely visualized. Following the pneumomediastinum, a small band-like opacity of a variable thickness and of modest dimensions, directed craniocaudally could be identified in the retrosternal space.

On dissection in a site corresponding to that of the shadows described, in some cases the thymus was found. In other cases, structures

which consisted of involuted thymic tissue and adipose tissue, and sometimes fibrous adipose tissue alone were demonstrated.—*Anthony A. Blasi, M.D.*

ADAMS, W. E. Differential diagnosis and treatment of congenital cystic malformation of the lung. *Dis. of Chest*, Jan., 1949, 15, 60-71.

The author's series of 30 cases from infancy to fifty-nine years of age is compared with 26 additional ones collected for differential diagnosis of congenital cystic malformation of the lung. The symptomatology results from: (1) symptoms secondary to infection of the cysts, and (2) ones due to overdistention of the cysts with changes of the intrathoracic pressures. In the first group, 27 cases show superimposed infections incorrectly diagnosed as followed: bronchiectasis, lung abscess, empyema, tuberculosis, pneumothorax, pneumonitis, and diaphragmatic hernia. Three cases demonstrate the pressure symptoms due to expanding cysts. Pathologically, the simple or multiple cysts show ciliated epithelium with inflammatory elements. Illustrative cases are presented showing how the correct diagnosis, made early, might have reduced the length of morbidity and patient incapacitation. Treatment consisted of surgical resection of the involved area without resultant mortalities. The author stresses the value of fluoroscopic and roentgenographic examination, along with the clinical course, as diagnostic measures for congenital cystic lung disease.—*Frederick R. Gilmore, M.D.*

WALKER, J. M., TAGGART, W. B., and STATON, H. J. Tension type of congenital pulmonary cyst. *J. Pediat.*, Nov., 1948, 33, 601-608.

Large tension type congenital pulmonary cysts are rare but are now surgically correctible. The authors report such a cyst successfully removed from a four month old infant.

In 1946 Gross listed four methods of relieving respiratory embarrassment in this condition:

1. Introducing a needle into the cyst.
2. Introducing a trocar and catheter for continued aspiration.
3. Marsupialization of the cyst onto the chest wall.
4. Enucleation of the cyst or removal of the containing lung tissue.

The author's case was a full-term male infant at birth. The child always appeared to breathe rapidly. Four months after birth the breathing

became more rapid and labored. The child appeared cyanotic and the right thorax appeared larger than the left, and a hyperresonant percussion note was obtained on the right side. Roentgenograms showed a large air-containing sac filling the right thorax. The cyst was in the anterior position on the lateral film. The cyst was decompressed by a needle with a tube attached and an under-water connection. On the following day the needle was replaced by a catheter. Successful decompression of the cyst was maintained for ten days and then it was surgically enucleated. Recovery was uneventful.

Congenital tension cysts of the lung are bronchogenic cysts arising in pulmonary tissue, through a developmental abnormality. Continuity with the bronchial tree may or may not be present. The cysts are lined with ciliated columnar epithelium and have smooth muscle and elastic tissue in their walls. Cartilage and mucous secreting glands are often present. The inflammatory cyst has a fibrous tissue lining. Secondary infection of a congenital cyst may destroy the lining membrane and make differentiation difficult.

Congenital cysts are usually small and asymptomatic. Occasionally a ball-valve mechanism may cause sudden rapid enlargement.

The differential diagnosis must include congenital diaphragmatic hernia, which can be ruled out by oral barium administration; emphysematous blebs of the lung, which are usually thin walled and on a pleural surface; and tension pneumothorax.

The authors discuss surgical measures for the correction of these cysts.—*Rolfe M. Harvey, M.D.*

ORTMAYER, M. Cystitis emphysematosa; with a report of the twelfth human case diagnosed at cystoscopy. *J. Urol.*, Nov., 1948, 60, 757-762.

About 50 cases of human cystitis emphysematosa have been described in the literature. Approximately four-fifths of these are autopsy reports. The etiology is controversial. Redewill divided the etiology into four groups:

1. Anaerobe gas-formers producing generalized virulent infections, terminating fatally with fulminating bladder emphysema.
2. A gas-forming colon bacillus producing cystitis and involving the mucosa and submucosa.

3. A bacterial cystitis emphysematosa in diabetics with hyperglycemia, over 200 mg. per 100 cc., the gas being the result of enzyme action in the bladder mucosa and submucosa.

4. Air or gas-forming bacteria introduced under the mucosa by trauma or by instrumentation.

Bloody frequent micturition is the common presenting symptom. In the roentgenogram, a ring of air may be seen outlining the bladder. Most of the cases were found at cystoscopy.

The author describes the cystoscopic appearance of the bladder mucosa in her case and reproduces films showing multiple negative shadows about the bladder periphery on a cystogram due to submucosal air-containing blebs. Her patient was a diabetic.—*Rolfe M. Harvey, M.D.*

SMITH, CHARLES EDWARD; BEARD, RODNEY. RAU, and SAITO, MARGARET TAIKO. Pathogenesis of coccidioidomycosis with special reference to pulmonary cavitation. *Ann. Int. Med.*, Oct., 1948, 29, 623-655.

After an incubation period ranging from one to three weeks, symptoms develop in approximately 40 per cent of infected males. However, three-fifths of the infections are completely asymptomatic. The pneumonic or respiratory symptoms which occur in two-fifths are of varying degrees of severity. Among females an increased frequency of erythema nodosum results in a somewhat higher proportion of clinically manifest disease. This erythema nodosum is a complication of the initial infection associated with the hypersensitive state.

Pleural effusion is another occasional complication which occurs relatively soon after the infection is acquired. Even though the fungus is usually recoverable from the pleural fluid, the infection is rarely progressive. A third complication of the primary infection may be pulmonary cavitation and even spontaneous pneumothorax or hydropneumothorax.

Its clinical manifestations are well known: extrapulmonary lesions of lymph nodes, bones, joints, central nervous system, peritoneum, genital tract, skin, mucous membranes of the mouth, indeed, of all organs and of all degrees of severity. The mimicry of extrapulmonary tuberculosis is notorious, as is the 50 per cent case fatality.

None of the many thousands of service men who were coccidioidin reactors when given their routine test on arrival at their stations

was ever known to have undergone dissemination. Disseminations occurred only in those who arrived uninfected, acquired infection and then disseminated.

Coccidioidal pulmonary cavitation, first reported in isolated instances, is now familiar. The thin wall with little reaction around may cause confusion with lung cysts.

There is general agreement that cavities may develop early in the course of the primary illness, often beginning within the pneumonic lesion in a week or two of the onset. On the other hand, the single or multiple pneumonic areas may reduce in size to nodular or irregular residuals over a period of weeks or months. The patient may be completely over his clinical illness with sedimentation rate normal and serologic tests waning. Then an excavation may develop and a cavity rapidly form.

The cavity may appear transiently during the acute infection and thus be missed. The cavity may develop months after the acute infection is over. Thus the association with the initial infection is readily overlooked. Moreover, cavities may develop after completely inapparent infection. Few cavities produce sufficient symptoms to warrant consulting a physician and his ordering a roentgenogram.

Ninety per cent of the cavities were single and 70 per cent were located in the upper chest.

In treating cavities, one must realize that while many cavities close quickly, a considerable proportion may remain open for many years, rarely producing serious health problems. Bed rest doubtless aids in closing cavities early in their evolution, but has limited value later. The risk of dissemination being negligible and possibility of contagion very remote, drastic intervention should be reserved for specific indications.—*Eugene J. McDonald, M.D.*

MACKIE, THOMAS T. Parasitic infection of the lung. *Dis. of Chest*, Nov.-Dec., 1948, 14, 894-905.

The author stresses the importance of protozoan and metazoan parasites as causes of clinical infection within the respiratory tract, especially since many Americans have been exposed recently to these diseases. He briefly outlines the characteristics and cyclic growth of each organism plus the pulmonary sequelae. *Plasmodium falciparum*, for one year in Panama military hospitals, caused 3.7 per cent of malaria patients to have malarial pneumonitis. *Entameba histolytica* is primarily associated

with colonic and hepatic infection, but occasionally involves secondarily the lung by perforation and direct extension of an hepatic abscess through the diaphragm.

The round worms, especially the hookworms, in migrating through the lungs, produce minute hemorrhagic lesions of the alveoli with occasional frank hemoptysis. *Ascaris lumbricoides*, being larger, may mechanically block the capillaries, with subsequent hemoptysis and pneumonitis. Trichinosis infections of lung show no specific pathology and any pneumonitis is probably bacterial in origin. The lung fluke, *Paragonimus westermani*, is the cause of endemic hemoptysis in certain geographical areas, by an inflammatory reaction with cyst formation and necrosis. Actual putrid abscess cavities or atelectasis may result which simulate clinical bronchiectasis. *Schistosoma japonicum* may produce multiple granulomatous lesions and abscesses which roentgenographically appear like miliary tuberculosis. With hydatid cyst formation in the lung, the *Echinococcus granulosus*, a dog tapeworm, may cause a malignant alveolar type cyst, which by trauma, may spread viable scolices via the blood stream with fatal consequences. The unilocular hydatid cysts are diagnosed roentgenographically by the presence of daughter cysts within the primary lung cyst wall, and have a better prognosis.—*Frederick R. Gilmore, M.D.*

MACHLE, WILLARD. Pathogenesis of industrial pulmonary disease. *Radiology*, June, 1948, 50, 755-759.

The author limits the discussion to subacute and chronic pulmonary disease resulting from agents in particulate state and of sufficiently low solubility to be capable of producing chronic rather than acute disease. After inhalation the dust particles are picked up by phagocytes, enter the lymphatics, migrate toward the hilar nodes and pleura and in part reach the general circulation through the thoracic duct. Local accumulations of dust occur in the periphery because of the death of the phagocytes. Peripheral accumulations will be prominent if the mass of incoming dust exceeds the drainage capacities of the lung. Following a very short period of inhalation of irritant dust, bronchiolar constriction, which, if continued, leads to stasis of secretions, patchy atelectasis and emphysema, results in reduction of pulmonary volume and increase in rate. Local

deposits in the lungs at first occur in the upper portions and the diaphragmatic surfaces remain free.

The old idea that pneumoconiosis resulted from the sharpness or the physical characteristics of the particles is not considered accurate. At the present time the solubility of the particle is considered the factor of importance, although other factors which influence the range of solubility should be considered.

The three conditions upon which the development of chronic pulmonary disease depend are: (1) chemical characteristic of the dust; (2) solubility rate of the particles within certain ranges; (3) adequate concentration of dust exposure continued for a sufficient period of time. Previous pulmonary infections and exposure to irritants, the piling up of phagocytes and obstruction by fibrous tissue will affect lymphatic drainage and the rate of development of pulmonary disease. While attention has been centered on the lungs, it should be recalled that considerable material will be carried by the general circulation to the liver, spleen, kidneys and bone marrow and the effects on these organs should be considered.—*J. N. Ané, M.D.*

SHAVER, CECIL GORDON. Further observations of lung changes associated with the manufacture of alumina abrasives. *Radiology*, June, 1948, 50, 760-769.

This is a report of 34 well established and 38 early cases of lung involvement encountered in certain men employed in the manufacture of alumina abrasives. The longest period of exposure was nineteen years and the shortest was eighteen months. While the disease was present previous to World War II, it was not recognized. Seven patients who were in desperate condition when first seen died within a relatively short period of time. It has been shown that once the disease becomes well established, progression and complete disability occur rapidly. One man who left the employment of the plant with a negative chest film showed evidence of disease one year later.

Cough, shortness of breath, pleuritic and substernal pain, and dark colored sputum were the symptoms noted in the well established group. The early cases are relatively free of symptoms and show practically no abnormal findings on chest films. Associated acute pulmonary infection has been found to play no major part in the progression of the disease.

Roentgen findings consisted of pneumothorax, emphysema, localized pleural effusion, widened mediastinal shadow, diaphragmatic adhesions and granular opacities in the upper portions of the lung fields. At fluoroscopic examination, in the presence of marked fibrosis, instead of the usual widening of the mediastinum on expiration and narrowing on inspiration, the opposite or paradoxical movement is noted.—*J. N. Ané, M.D.*

WILSON, STANLEY A. Delayed chemical pneumonitis or diffuse granulomatosis of the lung due to beryllium. *Radiology*, June, 1948, 50, 770-779.

Exposure to beryllium occurs in beryl mines, in the extraction of beryllium from the ore, in the production of salts and oxides of beryllium, in plants employing beryllium in alloys, in the coating of fluorescent, neon and radio tubes, and in chemical, pharmaceutical and research laboratories. The cases of acute pneumonitis were characterized by insidious onset, cough, dull, burning substernal pain, dyspnea, cyanosis and anorexia. The roentgen findings consisted of a diffuse haziness or ground-glass density similar to pulmonary edema one to three weeks after the onset of symptoms. This was followed by areas of soft infiltration similar to those seen in bronchial pneumonia with enlarged hilar structures and exaggerated lung markings. As these areas absorbed small nodules were noted which remained from one to four months. One or two cases showed some residual linear fibrosis.

In the chronic form, granular densities were associated in the next stage with a diffuse reticular pattern. In stage three, there was nodular involvement associated with hilar enlargement and small areas of emphysema.

In the differential diagnosis, pulmonary sarcoidosis, miliary tuberculosis, silicosis and other pneumoconioses must be considered. The pulmonary changes noted in erythema nodosum may be confusing but the skin involvement in this disease is typical. In virus pneumonia, the involvement throughout both lung fields is not usually uniform.—*J. N. Ané, M.D.*

BERGMANN, MARTIN, SHATZ, BURTON A., and FLANCE, I. JEROME. Apical pulmonary carcinoma and tuberculosis. *J.A.M.A.*, Nov. 13, 1948, 138, 798-801.

The differentiation of apical pulmonary tuberculosis from apical pulmonary carcinoma

is often difficult. Fifty-two per cent of all carcinomas of the lung occur in the upper lobes.

Previously, tissue for diagnostic study has been obtained by exploratory thoracotomy, needle aspiration or bronchoscopy, which are drastic, difficult and inadequate methods. The authors emphasize the value of examination of sputum, particularly in apical lesions, which will yield a positive diagnosis in from 60 to 88 per cent of carcinomas of the lung.

Three case histories are reported demonstrating the definite value of sputum examinations for tumor cells.

GARDELLA, GIOVANNI. Le alterazioni dello scheletro toracico nella diagnosi dei tumori pulmonari. (Alterations in the thoracic cage in the diagnosis of lung tumors.) *Radiol. Med.*, March, 1948, 34, 146-158.

The author calls attention to the role that alterations of the osseous components of the thoracic cage can play in the differential diagnosis of pulmonary tumors. They are most often manifest by compression effects (contiguity) or destructive, osteolytic metastatic implants involving the ribs or dorsal vertebrae. Such findings serve to focus attention on the presence of a pulmonary neoplasm and also serve to help differentiate as to the benign or malignant nature of the primary lesion. For example, aneurysm, tuberculosis, Pancoast tumor, osteosarcoma and ganglioneuroma are considered with respect to how they may alter the thoracic cage and the dorsal spine. In a series of 40 cases, 10, or 25 per cent, presented significant rib or dorsal spine abnormality. This seems to be a rather high figure. The author justly stresses the importance of minutely inspecting each rib in cases suspected of pulmonary neoplasm and the necessity for Potter-Bucky films as well as multi-angle roentgenograms. The accompanying illustrations and the bibliography are very commendable.—*Anthony C. Galluccio, M.D.*

CRIMM, PAUL D. Spontaneous collapse. *J. Thoracic Surg.*, Oct., 1948, 17, 662-680.

The author analyses the continuity of interstitial, mediastinal and subcutaneous emphysema. The few cases reported in the literature are reviewed and 2 cases are added.

The etiology, diagnosis and treatment of spontaneous collapse of the lung with air or blood are discussed. The most common etiologic

factors in the production of spontaneous pneumothorax in the healthy individual are emphysematous blebs in the pleura, while tuberculosis is the cause in the majority of cases of pathologic spontaneous pneumothorax.

Indirect pulmonary pneumoperitoneum is extremely rare. It has occurred following pneumothorax and during anesthesia, where excessive pressure has been the etiologic factor. A suspected fistula was the cause in a case of pneumonia of the left lower lobe and in another patient with tuberculosis it followed a left thoracoplasty. A valve-like fistula permitted leakage of air into the peritoneal cavity in the latter case.

Finally, spontaneous lung collapse, caused by the presence of extraneous air, is differentiated from the airless lungs in acquired collapse.—*Frederick Reis, M.D.*

BLADES, BRIAN. Empyema. *J.A.M.A.*, Nov. 27, 1948, 138, 943-946.

Since the advent of effective chemotherapy and antibiotics, empyema has become rare. Early parenteral and intrapleural use of penicillin aborts frank abscess formation in many cases, but sterile empyema is not cured empyema. Sterile pus may even produce empyema necessitans. There is still a tendency to mistake empyema for unresolved pneumonia. After weeks or months, bacteria attenuated by the antibiotic may revive and produce an active pyogenic infection. Penicillinase should be used in the laboratory to help identify organisms in aspirated pleural fluid from patients already under penicillin effect. Precise bacteriologic diagnosis is important to select patients who require streptomycin (tuberculosis, hemolytic influenza bacillus, Friedländer's bacillus and a few rare gram-negative bacteria).—*John Turner, M.D.*

CARSON, M. J., BURFORD, T. H., SCOTT, W. G., and GOODFRIEND, J. Diagnosis of pulmonary stenosis by angiocardiology. *J. Pediat.*, Nov., 1948, 33, 525-543.

The authors have found angiocardiology to be of value, particularly in the exact diagnosis of cyanotic congenital cardiac conditions. One of the authors has developed the tautograph, which is capable of making ten exposures in ten seconds, to facilitate the procedure of angiocardiology.

The patients fast for four hours preceding the examination. General ether anesthesia is

used in younger patients and local novocaine in older patients. Patients with cyanotic heart disease are given preoperative subcutaneous fluids plus concomitant oxygen with the anesthetic. The antecubital vein is cut down on and a few minims of 70 per cent diodrast is given after patency of the cannula has been determined by saline drip. If no reaction occurs the injection is completed, 10-18 cc. being used in infants up to two years of age, 20-30 cc. between the ages of two and ten, and 30-40 cc. up to fifteen years. The injection should be completed in two seconds.

The most useful views are the anteroposterior and left anterior oblique. Illustrative films are presented showing the visualization of the normal cardiac chambers and great vessels in these two projections. Following these illustrations various congenital cardiac anomalies are demonstrated by angiocardiology. These include non-functioning right ventricle with tricuspid stenosis, persistent truncus arteriosus, and tetralogy of Fallot.

The salient features of the tetralogy which may be demonstrated by angiocardiology include: (1) defect in the interventricular septum allowing medium to pass directly from the right to the left ventricle; (2) the presence of an overriding aorta as shown by simultaneous opacification of the aorta, pulmonary conus, and pulmonary arteries; (3) enlargement of the right ventricle, and (4) decreased size of the pulmonary arteries.

In the case of a non-functioning right ventricle with tricuspid stenosis angiocardiology will show opaque material passing from the right auricle to the left auricle with no visualization of the right ventricle.

In persistent truncus arteriosus with stenosis of the pulmonary arteries angiocardiology shows: (1) a much enlarged right ventricle; (2) a patent interventricular septal defect; (3) an overriding truncus, and (4) no pulmonary conus with small pulmonary arteries arising from the truncus.

The original article should be consulted in order to appreciate the excellent demonstration of these anomalies by angiocardiology by these authors.—*Rolfe M. Hartery, M.D.*

ABDOMEN

CAVE, PAUL. Stomach in femoral hernia. *Brit. J. Radiol.*, March, 1948, 21, 143-145.

This is the report of a case of a short woman with a femoral hernia who was examined with

a barium meal. During the examination the stomach and duodenum were observed to descend to a position in the left thigh in a femoral hernia. The position of the stomach permitted unusually satisfactory palpation during the examination. The gastric emptying time was normal. The patient complained of discomfort after meals or on standing or walking for long periods, but relief was immediate on lying down. The patient did not wear a truss and did not desire an operation.

A similar condition was reported in 2 patients in German literature in 1920, and a third was quoted, but the present case is the first in English and the first shown with a barium meal. The others were sudden in onset, followed trauma or exertion, and occurred in patients with a pre-existing femoral hernia. They were treated successfully surgically.—*E. F. Lang, M.D.*

BRALOW, S. P., SCHEINBERG, S., and NECHELES, H. Peptic ulcer and pregnancy. *Am. J. Digest. Dis.*, May, 1948, 15, 137-141.

It has been believed for many years that during pregnancy peptic ulcer rarely appears, rarely flares up and often heals. Gastric acidity tends to be decreased during pregnancy, but theories of mechanical and humoral factors producing this decrease are vague. Four clinical cases of ulcer complicating pregnancy are reported, of which 2, with no previous ulcer history, had serious episodes of hemorrhage. The authors believe that obstetricians should not feel safe in view of the reported rarity of the co-existence of peptic ulcer and pregnancy, but should study carefully all cases of persistent heartburn, epigastric distress, etc., in their patients, as peptic ulcer may produce serious complications during or shortly after pregnancy.

It is felt the number of ulcers observed in pregnancy may increase if the obstetrician is impressed with their possible co-existence and keeps this in his mind, when obstetric patients complain of symptoms that may be due to pregnancy as well as to peptic ulcer.—*Franz J. Lust, M.D.*

BASSLER, ANTHONY, and PETERS, A. GERARD. Distinctions between gastric sarcoma and carcinoma, with special reference to the infiltrating types of sarcoma. *J.A.M.A.*, Oct. 16, 1948, 138, 489-494.

This article is based on a series of 20 proved

cases of advanced sarcoma of the stomach. The authors are concerned with signs, symptoms and laboratory findings which could aid in making a preoperative diagnosis of gastric sarcoma. These findings are compared with similar features found in advanced gastric carcinoma. The authors believe that sarcoma of the stomach could be diagnosed more often. In 11 of the 20 cases reported (55 per cent) a presumptive diagnosis of sarcoma was made.

Ewing's classification of gastric sarcoma is used by the authors: (1) spindle cell myosarcoma, (2) lymphosarcoma, (3) miscellaneous round cell or mixed cell alveolar sarcoma. Of these, lymphosarcoma is said to comprise about 60-65 per cent of sarcoma encountered in the stomach. Eleven (or 55 per cent) of the author's series were lymphosarcoma.

The authors are impressed by the surprising wellbeing of a patient with advanced sarcoma. In their group of 20 patients, 12 (60 per cent) were employed at the time of examination.

The authors believe there are points of difference in the roentgen findings of these two malignant diseases of the stomach. Some of the gastric deformities to be observed in sarcoma include the following: (1) a rounded, well defined endogastric mass, bearing a demonstrable ulcerative niche; (2) a tumor arising on the greater curvature, even when it has the typical saucer shape of carcinoma; (3) giant rugae; (4) diffuse decrease in the size of the stomach; (5) absent or few "thumb indentations" characteristic of carcinoma, with the irregularity in gastric outline consisting of shallow serrations involving the stomach to considerable extent.

In conclusion the authors state that "in favor of a diagnosis of gastric sarcoma as compared to carcinoma in an average way," the following points are noted:

1. Average age for sarcoma is 38.5 years; in carcinoma it is fifteen years older.
2. Because of slowness of the growth, sarcoma may extend twice or even three times longer than carcinoma.
3. There is no relationship with peptic ulcer in sarcoma.
4. Weakness in cases of sarcoma is less than half that of carcinoma.
5. Loss of weight is about one-third that noted in carcinoma. In sarcoma there may be only slight anemia or none. In carcinoma it is more definite.
6. No jaundice is present in sarcoma; in

carcinoma it occurs in 23.2 per cent.

7. Palpable tumor in sarcoma is a little more than half as common as in carcinoma. The sarcoma masses are vague and doughy in consistency, whereas in carcinoma, generally, the mass is easily felt and firm to hard in character. Visible peristalsis is not noted in sarcoma.

8. The spleen is enlarged in 15 per cent of the cases of sarcoma and not present in carcinoma.

9. Virchow's gland is not observed in sarcoma.

10. Hydrochloric acid of the free and combined types was present in 75 per cent of the cases of sarcoma; this figure is much higher than that found in carcinoma.

11. Blood in gastric contents and stools is observed in one-third of the cases as compared to carcinoma.

12. The gastroscope is less valuable in diagnosing sarcoma than carcinoma.

13. Roentgenograms are valuable in both conditions, although less so in sarcoma than in carcinoma.

14. Roentgen evidence suggestive of sarcoma is present in 55 per cent of the cases.—*R. F. Niehaus, M.D.*

CONTI, JAMES G., JR., FOLTZ, THOMAS P., and STEVENS, G. ARNOLD. Surgical and roentgenologic aspects of duodenal diverticula. *J.A.M.A.*, Oct. 9, 1948, 138, 403-405.

The authors report 3 cases of duodenal diverticula which were operated upon with removal of the diverticula and complete relief of their symptoms. They believe that patients with a history of dyspepsia, characterized by pain and fullness after meals, in whom diverticula can be demonstrated roentgenologically, should be entitled to surgical extirpation of the lesion, if other causes are eliminated. They conclude that the majority of duodenal diverticula do not produce symptoms and require no treatment but that some diverticula of the duodenum produce symptoms that may be cured by surgery.—*C. Peter Truog, M.D.*

REID, DOUGLAS R. K. Argentaffinoma of the gastro-intestinal tract. *Brit. J. Surg.*, Oct., 1948, 36, 130-139.

Twenty-five cases of argentaffinoma are presented. Seventeen of these involve the appendix, 6 the ileum, and 1 each the colon and stomach. The incidence, pathology, and treatment of the tumor are discussed.

The author states that it is not possible to distinguish whether these lesions are benign or malignant on histopathological grounds alone. It is probably sounder to regard all carcinoids as potentially malignant and to classify them according to their behavior as localized, invasive, or metastasizing. Malignancy from appendicular carcinoid is extremely rare, only 17 cases having been reported. Extra-appendicular tumors occurring usually later in life are much more prone to display obvious malignancy. Growth of both primary and secondary tumors is very slow. Metastasis occurs chiefly to the lymph nodes of the mesentery while distant metastases have been found in the liver, and rarely in the retroperitoneal tissues, lung, pleura, brain, spinal meninges, pancreas, and inguinal lymph nodes. None of the 25 cases were diagnosed roentgenographically. The presenting symptom in the cases where the ileum was involved was that of a small bowel obstruction.

The treatment of choice in the benign lesions is local excision. In malignant carcinoid total extirpation is justified wherever possible. It has been suggested that irradiation be attempted on inoperable masses although the response to radiotherapy is not known.—*Charles W. Werley, M.D.*

GLASS, W. H. Small intestinal deficiency pattern; current status. *Am. J. Digest. Dis.*, Sept., 1948, 15, 294-298.

Idiopathic steatorrhea and the disordered motor function of the small intestine, if it be on the same basis, respond to vitamin B complex therapy. Depending on the intensity of the illness, other therapeutic measures as dietary alteration to give adequate caloric intake of assimilable foods, vitamin D in non fat vehicle, and parenteral calcium, if an insufficient amount is absorbed, are, of course, indicated. The basic disease, however, is the alteration of the jejunal mucosa by deficient intake of some factor or factors in the whole vitamin B complex. Other therapy is indicated to treat the bodily changes subsequent to the altered absorption of intestinal content.

Grossly visible steatorrhea only occurs where there is extensive fat and soap content in the stool. In cases studied here, all who demonstrated significant mucosal changes in the jejunum, presented steatorrhea on chemical analysis of the stool. It is concluded that idiopathic steatorrhea is the more advanced phase

of so-called vitamin B complex deficiency pattern. This latter term should no longer be used and Golden's terminology of disordered motor function with a subdivision as to the etiological basis is much the preferred terminology.—*Franz J. Lust, M.D.*

DELARIO, A. J. X-ray examination of the vermiform appendix. *Am. J. Digest. Dis.*, May, 1948, 15, 151-161.

Roentgen examination of the appendix may help to lower the mistakes in diagnosis. In 10-15 per cent of cases diagnosed as acute appendicitis a normal appendix is removed at operation. The percentage of appendices removed and not giving relief of symptoms in subacute and chronic appendicitis may be 25-70 per cent. Roentgen examination of the appendix will give data concerning anomalies: size, form, shape, and position of the appendix; its mobility; the presence of kinks, congenital bands and adhesions; its peristaltic action; its filling and emptying; the presence of fecaliths, foreign bodies, opaque stones; and the location of tenderness directly upon the appendix; all of which data cannot be obtained through clinical examination alone. Roentgen examination will disclose secondary signs of early appendiceal disease such as cardiospasm, pylorospasm, duodenal and ileocecal spasm, spasms of both lower ileum and cecum with paralytic distention and atony of these parts in late appendiceal disease.

The technique of the roentgenological exploration is given and the roentgen findings are discussed. Cases are shown of acute, subacute and chronic appendicitis; of appendiceal abscess, tuberculosis of the appendix, diverticula and intussusception, and of benign and malignant tumors.—*Franz J. Lust, M.D.*

GROSS, R. E., and WARE, P. F. Intussusception in childhood. *New England J. Med.*, Oct. 28, 1948, 239, 645-652.

A series of 610 cases of intussusception in infants and children is reported. Mortality rates varied significantly with the duration of symptoms before therapy: less than 24 hours, 0; 24 to 36 hours, 9 per cent; 36 to 48 hours, 13 per cent; more than 48 hours, 15 per cent. There were 180 patients in the group with symptoms less than 24 hours, without a fatality.

While intussusception in adult life usually has a discoverable mechanical cause, such as a

bowel tumor or a Meckel's diverticulum, intussusception in early life rarely has an identifiable etiology. In this series, only 5.4 per cent had a discernible mechanical factor: Meckel's diverticulum, 29 cases; intestinal polyp, 4 cases; lymphoma of bowel, 2 cases; duplication of terminal ileum, 1 case.

In the present series, 76 per cent were ileocolic; 14 per cent ileo-ileocolic; 5 per cent jejunoileal or ileoileal; and 2.1 per cent colocolic. Multiple intussusceptions occurred in 0.7 per cent. In 2.2 per cent the site was not stated.

Seventy-two per cent occurred in the first year of life, with the peak incidence between the third and eleventh months, in which 68 per cent of the cases occurred. Eighty-four per cent occurred before the age of two years. Sixty-five per cent of the patients were male.

Onset was usually abrupt, with rhythmic pain in 95 per cent, vomiting in 90 per cent, and blood in the stools in 85 per cent. In about half the cases with blood in the stool, the bleeding was grossly evident. Close to 85 per cent had a palpable abdominal mass. The clinical picture is so characteristic that in only about one-tenth of the cases, in the authors' estimation, is roentgenologic help needed. A plain film of the abdomen may show the intussuscepting mass, with dilated bowel proximal to it. In most cases, the intussusception has progressed to the colon where a barium enema shows the filling defect, and the postevacuation film may show a thin sheet of barium remaining around the intussusception.

While surgery is the treatment of choice in most cases, rapid reduction of the intussusception may often be accomplished by rectal injection of air or barium under fluoroscopic control. Limitations of this method revolve around the possibility of missing an intestinal tumor or Meckel's diverticulum, the lack of usefulness if any part of the intussusception lies above the ileocecal valve, and the uncertainty of complete reduction. It should be done only with the consent and cooperation of the surgeon who will accept the responsibility of operating on the child if the hydrostatic method fails.—*Henry P. Brean, M.D.*

RAVITCH, MARK M., and McCUNE, ROBERT M. Reduction of intussusception by barium enema. *Ann. Surg.*, Nov., 1948, 128, 904-917.

This paper presents an excellent discussion of the advantages of reducing intussusception

by means of barium enema. In a series of 27 cases treated previously by barium enema the authors demonstrate no mortality as compared with a 24 per cent mortality for a like series of 21 cases treated primarily by operative reduction. The criteria for successful reduction are (1) entrance of barium well into the small bowel, (2) return of feces or flatus, (3) masses no longer palpable, (4) patient clinically relieved, (5) blood free stool and recovery in stool of charcoal given by mouth.

The authors point out that a review of the literature over the last seventy-five years reveals that reduction of intussusception by hydrostatic pressure has consistently produced a low mortality and is a safer primary approach than surgery. It is not a substitute for surgery but rather the logical first step in the treatment of the condition. The reasons why this method has given superior results are listed as: (1) by fluoroscopic examination the diagnosis is established; (2) the accuracy of diagnosis of complete reduction is high; (3) the 2 per cent rate of recurrence is about the same by either method; (4) the possibility of missing a tumor by barium enema is low for the incidence of tumor is only 2.5 per cent in children under two years who suffer 70-90 per cent of the intussusceptions; (5) the delay caused by an unsuccessful attempt at reduction by enema is usually no more than a half hour; (6) experimental evidence shows that the 3 feet of hydrostatic pressure used for barium enemas will not rupture the bowel or reduce gangrenous bowel.—*T. D. Allison, M. D., and C. L. Hinkel, M.D.*

MANTOVANI, DINO, and STRANIERI, RODOLFO.

Un caso di doppia colecisti. (A case of double gallbladder.) *Radiol. Med.*, March, 1948, 34, 143-145.

The authors describe a case of double gallbladder and double cystic duct visualized by the Graham test. The clinical history is more or less typical of gallbladder colic. Films taken after the ingestion of the dye reveal an elongated, well delineated gallbladder with a well defined cystic duct. In close proximity to this gallbladder which lies anteriorly, a less well-defined second gallbladder shadow is seen. The cystic duct in this case is shorter. What appears to be a common duct is also visualized. It is stated that the lateral view separates these two shadows but this film is not reproduced. This is a roentgenographic and postmortem rarity

as some 8 cases have been reported to date. It is not uncommon to see at least part of the cystic duct. The response to the fatty meal was fairly good, though better in the case of the more anterior gallbladder.

The authors advance the theory that the cystic duct of the anterior, better visualized gallbladder, was probably equipped with Heister's valves while the shorter duct was not. Hence there would be a difference in contractability and emptying or function which might be responsible for the symptomatology in this case. Operative findings are not included.—*Anthony C. Galluccio, M.D.*

COMFORT, MANDRED, W., GRAY, HOWARD K., and WILSON, JAMES M. The silent gallstone; a ten to twenty year follow-up study of 112 cases. *Ann. Surg.*, Nov., 1948, 128, 931-937.

In a long term analysis of 112 cases of silent gallstones the authors state that approximately half developed symptoms. Of this group only 60 per cent experienced dyspepsia and of these 30-35 per cent had colic, and 5-10 per cent had jaundice. In the best surgical series there has been a 0.5 per cent mortality with asymptomatic patients while the mortality from cholecystectomy increases to 3 per cent after complications arise. No relationship of carcinoma of the gallbladder to silent gallbladder calculi could be shown. Although many surgeons favor operation of all proved gallstones, the authors regard cholecystectomy for these cases as optional. However, surgical intervention should not be postponed after more than mild symptoms appear.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

DOUBILET, HENRY, and MULHOLLAND, JOHN H. Recurrent acute pancreatitis; observations on etiology and surgical treatment. *Ann. Surg.*, Oct., 1948, 128, 609-638.

With 21 well-documented cases the authors demonstrate the value of section of the sphincter of Oddi as a definitive treatment for recurrent acute pancreatitis. Their studies support Archibald's contention that when a common biliary-pancreatic passageway exists, spasm of the sphincter of Oddi will produce reflux of bile into the pancreas. The diagnosis of acute pancreatitis is readily established by elevation of serum amylase. The quantitative evaluation of pancreatic function can be measured by the flow of pancreatic juice after the intravenous injection of an assayed quantity of secretin.

The absence of a rise in serum amylase during an attack of acute pancreatitis is occasionally seen in cases of long standing disease with fibrosis or calcification of a major portion of the pancreas.

The authors find that N/10 hydrochloric acid applied directly to the papilla of Vater will produce spasm of the sphincter which can be demonstrated by kymographic pressure tracings and cholangiograms through a T tube. Similar studies after the administration of morphine reveal spasm of the duodenal wall with resistance to the flow of pancreatic and biliary juices.

In sectioning the sphincter the approach through the common duct is recommended. After the cutting of the sphincter muscle the spasm is abolished. However, the inherent muscle tone of the duodenal wall remains and prevents reflux of the duodenal contents into the biliary tract. Postoperatively the patients show relief of pain, weight gain and freedom from recurring attacks.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

GYNECOLOGY AND OBSTETRICS

FOOTE, FRANK W., JR., and STEWART, FRED W.,
The anatomical distribution of intraepithelial epidermoid carcinomas of the cervix. *Cancer*, Sept., 1948, 1, 431-440.

Intraepithelial carcinomas of the cervix are defined by these authors as any tumor which has not broken through the basement membrane. This definition differs from some writers in that any tumor below the level of the epithelium has been considered to have become invasive. The authors have studied 27 specimens of intraepithelial carcinomas of the cervix by complete serial sections with reconstruction of the extent of the tumor, and on the bases of their findings have made the following observations:

(1) The most reliable biopsy procedure would require four specimens; one from the anterior and posterior lips, and one from each lateral angle of the external os. If a single biopsy is taken from the anterior or posterior lip, the probability of its being positive is approximately 50 per cent.

(2) All such patients would be cured by hysterectomy and the vast majority would have been cured by trachelectomy. The latter operation would require extensive serial sectioning to be certain that the entire tumor had been removed.

(3) They criticize an expressed opinion that in situ carcinomas of the cervix should be observed at frequent intervals rather than be removed. They show convincing evidence that most intraepithelial epidermoid carcinomas will ultimately become invasive.—*W. E. Childs, M.D.*

SOLOMON, EDWIN P., and LOVEMAN, ADOLPH B.
Chancre and carcinoma of cervix; simultaneous occurrence on opposite lips. *Am. J. Obst. & Gynec.*, Oct., 1948, 56, 694-699.

The authors report a case of chancre and carcinoma of the cervix occurring simultaneously on opposite lips. This type of case is a rarity. The case is reported to emphasize the importance of an accurate etiological diagnosis of cervical erosions and ulcerations. A positive differentiation of simple cervical erosion and carcinoma from chancre cannot be made except by dark-field examination and/or examination of tissue. Recognition clinically is dependent upon a high index of suspicion on the part of the examining physician.—*Mary Helen Cameron, M.D.*

COHEN, MORTIMER, and CRAVOTTA, CHARLES
A. Sarcoma of the uterus. *Am. J. Obst. & Gynec.*, Nov., 1948, 56, 997-999.

Sixteen cases of sarcoma of the uterus were found in a survey covering twenty-five years at the Elizabeth Steel Magee Hospital, Pittsburgh. This represented an incidence of 2.6 per cent of all uterine malignancies. Histopathologically, 7 of the 16 were leiomyosarcomas. Ten started in fibroids and 3 in endometrial stroma. Five patients of this series are still living. Sarcoma was an accidental finding following uterine removal for fibroids in each of the 5 surviving. Fifteen years is the longest period of survival. Metastases were rapid and extensive in 1 patient with uterine sarcoma complicating pregnancy.—*Mary Helen Cameron, M.D.*

GENITOURINARY SYSTEM

SAMUEL, ERIC. Calcification in suprarenal neoplasms. *Brit. J. Radiol.*, March, 1948, 21, 139-142.

A case of adrenal virilism due to adenocarcinoma of the cortex, in which massive calcification of the tumor was one of the presenting features, is reported. Other possible causes of massive calcification in the left hypochondrium are listed: calcified cysts or tuberculomas of the

spleen, or perisplenitis; infarcts, tumors or inflammatory and toxic conditions of the left kidney; tuberculous lymph glands; aneurysm of the celiac axis or splenic artery; calcified retroperitoneal hematomas or tumors; osteoma, osteochondroma or sarcoma of ribs; suprarenal tuberculosis, or neuroblastoma of the suprarenal body.

In hypernephroma and suprarenal adenocarcinoma the calcification occurs in areas of hemorrhage rather than in the tumor itself.—*E. F. Lang, M.D.*

BRAASCH, WILLIAM F., GREENE, LAURENCE F., and GOYANNA, RUY. Renal ptosis and its treatment. *J.A.M.A.*, Oct. 9, 1948, 138, 399-403.

Renal ptosis is not an abnormal condition and does not cause symptoms per se. It is only when complications develop that symptoms may arise. The majority of the authors' patients were women in the third to fifth decade who were thin and definitely underweight. Twenty per cent complained of urinary symptoms such as frequency, dysuria, and nocturia. Symptoms, as a rule, were ill defined.

Renal ptosis was divided into four grades based on degree of descent. Grade 1, those cases in which renal pelvis is situated opposite the third lumbar vertebra. Grade 2, the pelvis is opposite the fourth lumbar vertebra. Grade 3, pelvis is opposite fifth lumbar vertebra. Grade 4, the pelvis is below the fifth lumbar vertebra.

The incidence of pyelectasis and delayed emptying time was approximately the same in the first three grades of ptosis and *less frequent* in Grade 4, in which ptosis was most marked.

The degree of ptosis had no relationship to the symptoms of the patient.

The urogram is of vital importance. The explanation of the borderline pyelocaliectasis is the "flabby pelvis." The following factors may be present: (1) obstination at or near the ureteropelvic junction; (2) adynamic or atonic dilatation resulting from a previous renal infection; (3) imbalance of the renal innervation, with consequent atony. That pyelectasis, in many cases, is not caused by actual obstination, may be shown by (1) absence of retained fluid in renal pelvis, (2) the absence of retained medium shown in the ten minute delayed film, and (3) surgical exploration. Delayed urograms are made by retrograde injection of contrast

medium into the renal pelvis. The catheter is then withdrawn and roentgenograms are made at ten minute intervals. If the opaque medium persists in the renal pelvis fifteen minutes or more after withdrawal of the catheter, the delayed emptying time would indicate inadequate renal drainage. *Unless existence of stasis can be visualized in nephroptosis, surgical intervention is not indicated.*

Nephropexy was performed on 21 patients with primary nephroptosis from 1935 through 1944. The operation was employed only when the patient's symptoms and evidence of renal damage were caused by renal ptosis.

Symptoms were relieved in less than 50 per cent of the carefully selected cases following nephropexy.

The authors conclude that the results make them hesitate before advising surgery and that a conservative attitude should be employed.—*C. Peter Truog, M.D.*

Low, H. T., and COAKLEY, H. E. Leukoplakia of the renal pelvis. *J. Urol.*, Nov., 1948, 60, 712-713.

An unusual case of leukoplakia confined to a kidney pelvis without concomitant infection is described by the authors. The patient was first seen with complaints of right renal colic. A right retrograde pyelogram showed a moth-eaten appearance of the minor calyces of the right kidney. On the basis of this finding plus the finding of cornified squamous epithelium in flakes voided in the urine, a preoperative diagnosis of leukoplakia was made. This was confirmed by nephrectomy.—*Rolfe M. Harvey, M.D.*

CULP, O. S., and HARTMAN, F. W. Mesoblastic nephroma in adults; a clinicopathological study of Wilms' tumors and related renal neoplasms. *J. Urol.*, Oct., 1948, 60, 552-576.

The authors have attempted to classify embryonal kidney tumors in a more simplified fashion. More than fifty different names have been used in the literature to describe these tumors. The authors suggest the name embryonal nephroma to include all renal tumors of embryonic origin. In turn, these tumors may be subdivided into those of mesoblastic origin (cortex) and those of mesonephric origin (pelvis). The authors further subdivide the cortical tumors into: (1) mixed; (2) carcinoma; (3) sarcoma; and (4) undifferentiated.

Mixed Cell Type. These tumors contain both

epithelial and connective tissue elements with varying degrees of cellular differentiation. The group includes Wilms' tumors. Illustrative case histories and roentgenograms are presented. This group includes the commonest mesoblastic nephromas. The age incidence ranges from sixteen to eighty years. There was no significant difference in sex distribution or site of the lesion between the right and left sides. Eighty-four per cent of the cases had a palpable tumor, 72 per cent had pain, and 53 per cent had hematuria. The known mortality was 82 per cent. The most frequent site of metastasis was the lymph nodes and then the lungs and liver.

Carcinoma. The authors consider embryonal carcinoma to be mixed cell tumors in which epithelial elements dominate the histopathological picture. A few case reports with illustrative films are presented.

Sarcoma. The authors found only one tumor in their group which showed only embryonic connective tissue elements. They feel that most reported sarcomas belong in the mixed cell group. Most reported cases in this group died soon after nephrectomy in spite of post operative irradiation.

Undifferentiated. Most highly malignant cortical tumors can be identified as undifferentiated carcinoma or sarcoma.—*Rolfe M. Harvey, M.D.*

ARNHEIM, F. K. Carcinoma of the prostate; a study of the postmortem findings in one hundred and seventy-six cases. *J. Urol.*, Oct., 1948, 60, 599-603.

The material for this study was obtained from 21,718 autopsies performed at the Cook County Hospital from 1929 to 1946. One hundred seventy-six cases of carcinoma of the prostate were found. Ninety-six per cent of these were adenocarcinoma and 4 per cent squamous cell carcinoma.

Thirty-three per cent had no gross metastases. Of the 37 cases in which death was not due directly to carcinoma, 81 per cent had no demonstrable metastases. One-third of the metastases were visceral and the remaining two-thirds were to the bones and lymph nodes. The order of frequency of involvement of the lymph nodes was periaortic, iliac, tracheobronchial and inguinal. Eighty-two per cent of the bone metastases were to the vertebrae, ribs and pelvis. The bladder was involved in 44 per cent of the cases. The youngest age at which carcinoma of the prostate was found was

forty-two years. Seventy-seven per cent of the cases were between the ages of sixty and eighty.

The authors feel that metastases must be by way of the vertebral veins as proposed by Batson. They conclude that carcinoma of the prostate is biologically active in some individuals and inactive in others.—*Rolfe M. Harvey, M.D.*

NERVOUS SYSTEM

SMITH, C. A. Paraganglioma (pleochromocytoma). *J. Urol.*, Nov., 1948, 60, 697-701.

The author reports the case of a twenty year old soldier who had been wounded in the chest and extremities in 1944. Physical examination showed marked fluctuation in blood pressure readings. The patient had noticed blanching of the finger tips, especially in cold weather. He had also been told in the past that his blood pressure was high. Physical examination showed the blood pressure 180/100 in the right arm and 160/98 in the left arm. Cold pressor tests with sedation and ergotamine showed fluctuations of the blood pressure from 126/88 under sedation to 204/146 with the extremities in cold water, and the patient receiving ergotamine.

Roentgen studies of the abdomen showed a mass 6.5 by 5 cm. containing calcium flecks between the transverse processes of the second and third lumbar vertebrae on the left side. An intravenous urogram showed lateral displacement of the left ureter. At operation the mass was removed and the patient went into immediate shock for thirty-six hours. This was treated by adrenalin, adrenal cortical extract and blood and normal salt solution by vein. The pathological diagnosis on the operative specimen was paraganglioma (pleochromocytoma).

The pleochromocytoma is a tumor arising from chromaffin cells in the medullary portion of the adrenal gland. Similar tumors may arise in the dorsal vertebral ganglia, the carotid bodies and the gonads. The chromaffin cells elaborate epinephrine which is a vasoconstrictor and may, in abnormal amounts, induce paroxysmal hypertension. Tumors of these cells occur only in adults and are usually benign.

Compression of the tumor by physical exercise or surgical massage causes a sharp rise in blood pressure, as well as headache, dizziness, weakness, and palpitation. Eventually shock may result. These symptoms, the pres-

ence of pressor substances in the blood, glycosuria and roentgenography, including intravenous urography and perirenal air insufflation, are all diagnostic aids.

Roentgenograms may show a mass in the adrenal area with or without calcification. Intravenous pyelography may show renal or ureteral displacement. Perirenal air insufflation may show tumors not otherwise detectable.

The treatment is surgical.—*Rolfe M. Harvey, M.D.*

SKELETAL SYSTEM

ELLIS, V. H. Squamous-cell carcinoma of the nail bed. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 656-658.

Squamous cell epithelioma of the nail bed or sulcus is a well known but uncommon type of neoplasm. It is often mistaken for chronic paronychia. The insidious progress of the tumor and the frequency with which it is wrongly diagnosed make it of interest and importance. Ellis states it must be distinguished from malignant melanoma of the nail. Both are found more often in the fingers than the toes, and the thumb is the digit most often affected, the right more so than the left. There is often a history of trauma or infection which proved resistant to treatment. Metastases in the phalanges of the hand from bronchial carcinoma must also be considered in the differential diagnosis.

Three cases are reported, 2 in the thumb and 1 in the terminal phalanx of the right middle finger.—*R. S. Bromer, M.D.*

EDMONDS, H. W., COE, H. E., and TABRAH, F. L. Bone formation in skin and muscle; a localized tissue malformation or heterotopia. *J. Pediat.*, Nov., 1948, 33, 618-623.

The authors report the fourth case of bone formation within skin, subcutaneous tissue, and muscle occurring in a child. The child was born prematurely and weighed 3 lb. 15 oz. at birth. At the age of one month a small hard area was noted in one breast. The child was exposed to the sun and it was noted that greater reddening of the radial side of the left arm occurred than in the rest of the skin. Numerous enlargements of the left upper extremity became apparent during the next few months and this was followed by spontaneous extrusion of calcareous material. Laboratory studies were essentially negative. Roentgenograms showed extensive soft tissue calcification of the left upper ex-

trinity. Numerous masses were dissected out and histopathologic examination of these masses showed the presence of mature bone.

The authors summarize the previously reported cases occurring in children of abnormal bone formation in the skin, subcutaneous tissues, and muscles. The lesions did not recur following removal. The authors feel that this is a case of heterotopic bone formation, formation of normal tissue at an abnormal site. Other conditions to be differentiated are localized and disseminated calcinosis, traumatic ossifying myositis, progressive ossifying myositis and metastatic calcification with hyperparathyroidism.—*Rolfe M. Harvey, M.D.*

BRAILS福德, JAMES F. Ossifying hematoma and other simple lesions mistaken for sarcomata; the responsibility of biopsy. *Brit. J. Radiol.*, April, 1948, 21, 157-170.

James Ewing stated, "The whole clinical and radiological picture of the case of bone sarcoma usually furnishes a better conception of the diagnostic and therapeutic problem than can be obtained from a biopsy." A biopsy is necessarily only a minute fragment and cannot show the entire picture. Proliferating cells in dysplasias, response to trauma, infection, endocrine or vitamin deficiency, and neoplasia can be interpreted by various observers as representing all phases between simplicity and rapid malignancy. Biopsy may lead to an unnecessary amputation or it may be the cause of serious delay.

The essential information regarding any tumor is whether it is benign or malignant. At times the clinical and roentgenological features are indefinite, but Brailsford has found that in this type of case the histopathological features have been equally indecisive. The most valuable evidence is a combination of clinical and roentgenological observation, prolonged over a period depending on the rapidity of the change.

Several cases are presented to illustrate these statements. Ossifying hematomas and certain sarcomas may both show massive dense calcification in a patient with a palpable mass, and possibly no history of trauma. One such patient had four operations in a six month period. Biopsies at the time of the first two operations were reported as showing benign chondroma, at the third a chondrosarcoma was diagnosed, and finally the limb was disarticulated. The author, who had seen the films only in consultation, had reported a chondrosarcoma before the first biopsy.

Ossifying hematoma occurs in osteogenesis imperfecta and the mass is easily palpable, covered by stretched skin, with possible venous distention, and even edema. Eventually these masses are incorporated into the shaft of the bone which is then widened, irregular, and has coarse trabeculations.

A patient, aged three months, presented a non-tender, hard, fusiform swelling of the femur which after roentgen and clinical examinations was thought to represent an osteogenic sarcoma. The author was asked for an opinion and he stated that the lesion was an ossifying hematoma. On vitamin C therapy the hematoma was gradually absorbed.

Large hematomas may develop in sites of injury when the nerve supply is damaged. Injury sustained during periods of excitement may lead to hematomas when the patient has no memory of the trauma. Massive callus around a "march fracture," or calcification in hemorrhage due to hemophilia, also occurs. All of these have at times been mistaken for sarcoma. Unusual calcification occurs in the medulla of long bones, and usually represents an infarct. These are clinically insignificant, but even these have been investigated by biopsy by inexperienced observers and this has resulted on occasion in amputation. Septic foci, as osteoid osteoma, have been confused with sarcoma, as has melorheostosis.—*E. F. Lang, M.D.*

PONSETI, IGNACIO. Bone lesions in eosinophilic granuloma, Hand-Schüller-Christian disease and Letterer-Siwe disease. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 811-833.

Eight cases were selected to illustrate in this paper the clinical, roentgenographic, and histopathologic characteristics of bone lesions occurring in eosinophilic granuloma, Hand-Schüller-Christian disease and Letterer-Siwe disease. Although the cause of these diseases is still very obscure, studies made during the past decade have established that they probably represent forms of the same pathological process. This series of cases is presented by Ponseti mainly to corroborate this modern trend of thought.

The solitary eosinophilic granuloma of bone is the mildest form of this group of diseases. The local symptoms are tumor, tenderness and very slight pain. The roentgenograms show a more or less clear-cut defect, well outlined by normal appearing bone. There may be reactive periosteal new-bone formation. A case of a solitary lesion has a good prognosis, and the lesion does

not recur after its surgical removal or after roentgen therapy. However, malignant forms may occur which are resistant to treatment and which may recur, producing great bone destruction. Even in these instances, the general outlook for the patient is good. Patients with multiple eosinophilic granuloma may or may not show signs of general illness.

Two cases are cited to show that intermediary forms between multiple eosinophilic granuloma and Hand-Schüller-Christian disease exist. Likewise, two others are cited which were considered to be transitional forms between Hand-Schüller-Christian disease and Letterer-Siwe disease. The solitary eosinophilic granuloma of bone and the uncomplicated multiple eosinophilic granuloma form a distinct clinical group. However, from a clinical point of view, it would be convenient to group cases of multiple eosinophilic granulomas of bone, with involvement of other organs, under a common heading with Hand-Schüller-Christian disease and Letterer-Siwe disease. The age of patients in this group varies, although it is often during early childhood that symptoms appear, usually in an insidious manner.

A peculiar inflammation of the gingivae, with hypertrophy and, occasionally, ulceration of the gums, is frequently seen as an early symptom. The roentgenograms of the maxilla showed small cystic areas of bone destruction adjacent to the alveoli in 3 of the cases of the series. More or less extensive infiltration in both lung fields is often seen on roentgenographic examination.

Bone lesions were very frequent. The skull was involved in all of the patients but one, where the lesions were limited to the extremities. Any bone may be affected, even the metacarpals and phalanges. The roentgenographic appearance of the bone lesions in Hand-Schüller-Christian and in Letterer-Siwe diseases was usually identical to that seen in lesions of solitary and multiple eosinophilic granulomas. The areas of bone destruction were frequently sharply outlined and the surrounding bone appeared normal. In one patient, very destructive lesions were seen with destruction of the cortex and abundant reactive periosteal new-bone formation.

All of the bone lesions explored were found to be filled with granulomatous tissue, made up of a great number of large, mononuclear cells, probably histiocytes, and a small number of leukocytes. Except in the typical eosinophilic

granuloma, eosinophils were not present and the cytoplasm of the histiocytes appeared to be finely or coarsely vacuolated. In other cases, the granulomatous tissue was made up of extensive foam cells. Intermediary stages between these different types of granulomatous tissue were seen in one lesion of one of the cases. The structures surrounding the areas of bone destruction were in no instance infiltrated by the granulomatous tissue, even in the most malignant appearing lesion.

Roentgen therapy was given to the bone lesions in all of the patients. The pain was relieved in each case a few days after treatment; however, it was difficult to evaluate the effect of the roentgen treatments on the development and final outcome of the bone lesions and on the disease as a whole. In one case, where one of the bone lesions and a group of lymph nodes were not treated, the pain persisted in the untreated lesion, but rapidly disappeared in the treated areas; yet the bone lesions filled in with normal appearing bone at the same rate, regardless of whether or not they had been treated. Likewise, the treated and untreated cervical lymph nodes regressed at the same rate. In another case, the infiltration of the lung disappeared without treatment. In another instance, the infiltration disappeared one year after roentgen therapy; yet in another, there was no change in the pulmonary infiltration despite the irradiation. Notwithstanding these experiences, the author believes that roentgen therapy usually has a favorable influence upon the granulomatous lesions in eosinophilic granuloma, Hand-Schüller-Christian disease and Letterer-Siwe disease, and that it should always be given to these patients until the etiology of these diseases has been discovered.—*R. S. Bromer, M.D.*

WILSON, JOHN C., JR. Streptomycin in the treatment of chronic infections of bone. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 931-944.

In this paper, the author presents 25 cases of chronic osteomyelitis in which discharging sinuses had been present for an average of nineteen months. Many types of treatment had been tried, without success. In an effort to promote healing, the following plan of therapy was tried:

1. Thorough investigation of the wound bacteria;
2. Radical sequestrectomy after adequate preoperative preparation;
3. The use of streptomycin and penicillin be-

fore, during, and after surgery;

4. Meticulous wound care after surgery to prevent contamination.

Twenty-one patients responded very favorably to this plan of treatment and their wounds healed. Four patients failed to respond and all had amputations. Wilson emphasizes very strongly that the use of streptomycin offers no panacea for the treatment of chronic osteomyelitis. The drug is not a replacement for adequate surgery; but when combined with through sequestrectomy, it is beneficial in the promotion of healing. No claim, also, is made that the course of the disease has been altered permanently or that a cure has been obtained in any case. The salutary response of the patients which allowed their prompt return to a healthy, useful life, persuaded the author to present this study as a preliminary report.—*R. S. Bromer, M.D.*

WARRICK, C. K. Posterior dislocation of the shoulder joint. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 651-655.

Posterior dislocation of the shoulder is an unusual injury and there is often much delay before the diagnosis is made. This is partly explained by the rarity of the injury which, being unsuspected, is not recognized when physical signs are masked by swelling. If the condition is borne in mind when the patient is examined and the roentgenograms are studied, the diagnosis should not be missed. A single anteroposterior view of the shoulder joint is inadequate. A pair of stereoscopic films is desirable, but for routine emergency work other projections are necessary. A vertical view should be secured, either with the limb abducted and the tube directed toward the axilla, or with the tube above the shoulder and a curved cassette in the axilla. When this is impossible a profile or posterior view of the scapula may be substituted.—*R. S. Bromer, M.D.*

KHOO, F. Y., and KUO, C. L. An unusual anomaly of the inferior portion of the scapula. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 1010-1011.

A case of unusual anomaly of the inferior portion of the scapula is reported. The patient was a Chinese male, aged forty-two. During a fluoroscopic examination of the chest, an unusual notching of the inferior portion of the right scapula was noted; the left scapula appeared to be normal. A roentgenogram of the

right scapula showed that it was shorter than normal, owing to the absence of its lower fourth. The inferior aspect, instead of being pointed, ended in two processes, one on each side with a deep semi-elliptical notch between them. The lateral process was somewhat lower and narrower than the medial process, and had two larger projections or spines. The medial process was somewhat blunt. The axillary border of the scapula was slightly wavy in outline and was mildly concave. The vertebral border was fairly straight, except for a slight inclination lateralward above the spine of the scapula.

The authors quote Hrdlička's study of the human scapula. They feel that the scapula found in their patient can reasonably be considered as showing a developmental anomaly rather than just a developmental variation.—*R. S. Bromer, M.D.*

VITT, ROBERT J. Dislocation of the head of the fibula. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 1012-1013.

Dislocation of the head of the fibula is a rare injury, usually associated with a fracture at a lower level of the tibia. The author reports 4 cases in which the dislocations resulted from parachute-landing falls. The patients were males ranging from eighteen to twenty years of age. All the dislocations were anterior and were associated with inversion ankle sprains of varying degree. Roentgenograms showed forward and slight lateral displacement of the head of the fibula. There were no signs of tear of the cruciate ligament or collateral ligament. Roentgenograms of the tibial and fibular shafts and the ankles revealed no fracture in any of the patients.

In assuming the "parachute-landing position," paratroopers are taught to flex their legs and keep their feet together. In this manner, the fibular collateral ligament and the biceps femoris are in a relaxed state. As sharp inversion of the ankle causes tension of the peroneal muscles, and a lateral twisting motion of the trunk is transmitted to the tibia, the fibula is free to dislocate anteriorly. The author assumes that this is the mechanism of the dislocation.—*R. S. Bromer, M.D.*

FAIRBANK, T. J. Knee joint changes after meniscectomy. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 664-670.

This paper is the record of an investigation of changes found in the knee joint at intervals

ranging from three months to fourteen years after meniscectomy. Fairbank in searching the literature could find only one reference to these changes. Of the roentgenograms shown, one depicts the formation of a ridge from the margin of the femoral condyle in a patient aged forty years, six years after removal of the medial meniscus. In another patient, aged thirty-six, flattening of the femoral condyle was shown seven years after removal of the medial meniscus. In a patient, aged twenty-five, narrowing of the joint space laterally and widening medially was demonstrated five months after removal of the lateral meniscus.

Fairbank concludes that changes in the knee joint after meniscectomy include ridge formation, narrowing of the joint space, and flattening of the femoral condyle. His investigations suggest that these changes are due to loss of the weight-bearing function of the meniscus. Meniscectomy is not wholly innocuous as it interferes, at least temporarily, with the mechanics of the joint. He thinks it is likely that narrowing of the joint will predispose to early degenerative changes, but a connection between these appearances and later osteoarthritis is not yet established and is too indefinite to justify clinical deductions.—*R. S. Bromer, M.D.*

LEVEUF, JACQUES. Results of open reduction of "true" congenital luxation of the hip. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 875-882.

This paper, the author states, deals only with "true" congenital luxations of the hip. It deals with advances since he published with Bertrand a book on this subject. In luxation one always finds an interposition of soft tissues between the head of the femur and the acetabulum. A narrow hourglass constriction of the capsule is present, confining the head. The acetabulum is obstructed by the inferior fold of the capsule. A cartilaginous roof (or limbus) is pushed down into the joint by the head and a huge ligamentum teres is present in half of the cases. The head is round in shape and is of small size. After the interpositions have been removed, the acetabulum itself appears to be of fair size and depth.

In subluxation, interposition of soft tissues never exists. The most important lesion is the limbus which is pushed against the iliac bone. Atrophy of the roof causes the acetabulum to assume an oval shape. The head of the femur is bulky and out of shape so it is difficult to get

good congruence of the joint after reduction.

All of these anatomical facts, the author claims, can be easily shown by arthrography. At the same time it can be seen whether or not closed reduction is perfect. His experience indicates that in true luxation, clearly established by arthrography, the interposition of soft tissues makes a correct reduction of the displacement impossible without open operation.

This study is based on a total of 318 hips operated upon between 1941 and 1947. There were 119 primary open reductions, 96 open reductions with shortening of the femur, and 103 secondary open reductions for reluxation after closed treatment. There were 5 deaths in the series, a fatality rate of 1.57 per cent. The results are given in detail. Leveuf states that it would be certainly better to avoid reluxations and secondary subluxations. That is why it is necessary to check the reduction, by means of arthrography, in all cases of congenital dislocation of the hip. Then one can verify that it is impossible to obtain a good result in true luxation without primary open reduction.

The article is well illustrated with roentgenograms showing the findings in the dislocated hips after injection of the opaque material, and also the results of operative procedures. His previous article describing the arthrographic procedure in more detail was abstracted in this JOURNAL, March, 1948, vol. 59, p. 465.—R. S. Bromer, M.D.

LE MESURIER, A. B. Developmental coxa vara. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 595-605.

Despite the fairly extensive literature, and probably because the condition is not common, the real nature and severity of developmental coxa vara have seldom been recognized as soon as they should be, and treatment has not usually been started until there was marked deformity. The condition is characterized by the development, at the age of three or four years, of a limp or waddle which is usually painless and is progressive. A varying degree of coxa vara is present on one or both sides, but the striking feature is the roentgenographic appearance of a gap in the neck of the femur just distal to the epiphyseal line, together with a bend in the femoral neck at this level. This roentgen appearance is, in itself, almost sufficient to establish the diagnosis as soon as the patient is first seen.

The condition is rare and few large series of

cases have been reported. In the series reported in this paper, there were 15 cases. The roentgenographic appearances were very similar in nearly all cases. Even in early stages, when the child first began to limp, a gap in the bone was already obvious. It crossed the neck of the femur distal to the diaphyseo-epiphyseal junction. In most cases it ran part of its course parallel to the epiphyseal line, but towards one end, usually the lower, it branched away from it, and in some cases also usually at the lower end, it divided into two, leaving a triangular portion of bone more or less isolated. The gap was not broad and it did not follow a straight line with clear-cut edges; the margins were usually uneven. The bone was abnormal in appearance, particularly just distal to the gap; irregular areas of greater density alternated with areas of lesser density, giving rise to the appearance often described as "fragmentation." In no case was there increased density of the femoral head suggesting necrosis of the bone such as may occur in slipped epiphysis or in fractures at this level. The density of the head was often less than normal. The epiphyseal line was usually narrow, and sometimes it could only be seen with difficulty. The gap in the bone in this condition is not just at the diaphyseo-epiphyseal junction as in slipping of the upper femoral epiphysis.

In some early cases of coxa vara in which the deformity was not marked, the gap in the bone ran in a direction more horizontal than vertical. As deformity increased the head rotated downwards and both the gap, and what could be seen of the epiphyseal line, became more vertical.

No tissue was removed for pathological examination, so no information is added to the origin or cause of the condition.

In the treatment of developmental coxa vara, the coxa vara deformity and the gap in the femoral neck must both be taken into consideration. Traction is not satisfactory. It seems unwise, also, to complete division of the neck at the gap by operation, or to do an osteotomy through the neck distal to the gap. Unless the deformity is very severe indeed, limitation of abduction can be overcome and shortening can be reduced by the safer procedure of osteotomy between the trochanters, or below them, the lower fragment being abducted widely. Abduction osteotomy is a satisfactory method of treatment in cases in which the coxa vara deformity is bad enough to require correction. It

leaves a hip joint which may not be perfect in function, but which is much better than it was, and which is unlikely to get any worse for the reason that the gap in the neck becomes closed. In early cases the most important thing is to close the gap before deformity becomes disabling, and it would seem better, if possible, to do this without osteotomy which may distort the mechanism of the hip. Since healing of the gap after osteotomy seemed to be due to elimination of the shearing forces, it was thought that the same result could be obtained by insertion of a Smith-Petersen nail. In addition, grafting was attempted; two tibial grafts, placed cortex to cortex, were placed in a drill-hole in the femoral head which was drilled through the neck into the head. It would seem that this is much the best way to secure closure of the gap. The objection that at this age a bone graft across the epiphyseal line may arrest growth applies very little in these cases, because in any event growth in length here will be almost negligible.—*R. S. Bromer, M.D.*

VITERBO, FRANCESCO. Contributo radiologico alla conoscenza delle cisti da echinococco vertebrale. (Roentgenological contribution to the study of vertebral echinococcus cysts.) *Radiol. med.*, Feb., 1948, 34, 75-83.

The author presents a case of a female patient, aged 32, who was hospitalized one month after the onset of the disease characterized by pain of increasing severity in the right iliac fossa radiating to the right lower extremity and aggravated by physical activity.

A roentgen examination showed a large osteolytic bone defect of the right half of the body of the first lumbar vertebra with no evidence of compression, no wedging, no gibbus and with normal disc spaces.

The patient was immobilized in a plaster of paris jacket and was given roentgen therapy. At the completion of treatment a second roentgenographic examination showed partial repair in the right half of the body of the vertebra where there was evidence of sclerosis and calcification in a network which continued into a mass the size of an orange. This mass extended downward into the paravertebral region to the level of the lower border of the second lumbar vertebra. Its margin was calcified and it contained numerous lacunae which were outlined by a similar network of calcification and sclerosis.

The author considers in some detail the differential diagnosis of the following bone dis-

eases: tuberculosis, tumors, solitary cyst, parasitic cysts.

Although localized cystic tuberculosis may be difficult to exclude in certain cases, in this case the massive involvement without extension to the intervertebral disc is not in favor of a diagnosis of bone tuberculosis.

Giant cell tumor is usually limited to the bone involved and is of slow growth. The possibility of hemorrhage with subsequent reparative changes may make its exclusion as a diagnosis difficult in this case.

Bone localization of the *Taenia echinococcus* occurs in 2 per cent of cases. Probably because of its rich blood supply the vertebral column is the commonest site and represents about 40 per cent of cases.

The roentgen findings in this case are typical of the unilocular hydatid cyst in a vertebral body.

The response following radiation therapy with bone repair, calcification and sclerosis of the cyst and with return to a nearly normal function of the spine may have been a fortuitous coincidence. It is difficult to understand what mechanism was involved in this response, since to date roentgen therapy has not been considered effective in the treatment of hydatid cysts.—*Anthony A. Blasi, M.D.*

LISCHI, GIANCARLO. Due casi di vertebra eburnea apparentemente primitiva. (Two cases of primary sclerosis of a solitary vertebra.) *Radiol. med.*, July, 1948, 34, 385-399.

The author reviews the classification of sclerosis of a solitary vertebra. He classifies these lesions as (1) neoplastic diseases, either primary or metastatic; (2) sclerosis, secondary to systemic or local disease; (3) unknown etiology. Under neoplastic primary disease he mentions osteoblastic varieties of primary bone sarcoma. Under metastases he lists order of frequency as carcinoma of prostate, breast, especially the scirrhous type, stomach, colon, and hypernephroma. Under systemic diseases he lists various type lymphomas, Paget's disease, syphilis, tuberculous spondylitis, staphylococcus, and/or streptococcus spondylitis, post traumatic collapse of a vertebra (Kummell's disease) and myelosclerosis. Under unknown etiology he makes the point that diagnosis is only possible by exclusion and prolonged follow-up studies. He reports 2 asymptomatic cases evidently belonging to the latter group,

each of which had been followed for many years without known pathology.—*C. A. Priviteri, M.D.*

ROCHE, MAURICE B. Bilateral fracture of the pars interarticularis of a lumbar neural arch. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 1005-1008.

A case of bilateral fracture of the pars interarticularis of a lumbar neural arch is reported. The patient, a male, twenty-two years of age, sustained multiple injuries when a jeep, in which he was riding, overturned. In addition to other injuries, roentgenograms showed bilateral fractures involving the isthmuses on both sides of the neural arch of the third lumbar vertebra. These were demonstrated in anteroposterior, lateral, right and left postero-oblique views.

The genesis of a defect or solution of continuity in the interarticular portion of the neural arch of a vertebra, known as "spondyloschisis" has been considered by some writers as congenital, by others as due to trauma. Very little mention is made in the literature or in textbooks on fractures of this seemingly unique lesion, namely, acute traumatic spondyloschisis unaccompanied by spondylolisthesis. It is thus true, as shown by the case reported, that an intact portion of the spinal column, free from congenital defect, is also susceptible to acute traumatic spondyloschisis.

Later roentgenograms approximately four months after the accident showed healing of the fractures.—*R. S. Bromer, M.D.*

CALDWELL, GUY, A., and SHEPPARD, WILLIAM B. Criteria for spine fusion following removal of protruded nucleus pulposus. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 971-980.

The authors studied 75 patients in whom protrusion of the nucleus pulposus was proved at operation and who returned for roentgenographic and clinical re-examination. Cases were eliminated from the study as follows: (1) those upon whom spine fusions were done at the time of the original operation; (2) those in whom no definite pathological conditions could be found to account for symptoms; (3) those in whom other pathological conditions could be demonstrated to explain the symptoms.

Their study suggests the following: Excellent results can be obtained in as high a percentage of cases by laminectomy alone as by the combined operation. Hypertrophic changes of variable degree, with or without narrowing of the

disc, occurred in 69.3 per cent of the cases studied. Functional end results did not correlate with or depend upon the presence or extent of such postoperative changes. The end results were not significantly related to the existence of anomalies. Recurrences took place in 8 per cent of the cases studied, but did not seem to relate to the presence of anomalies or postoperative narrowing of the disc and hypertrophic changes. The number of recurrences was small, and there was nothing in the preoperative history and findings which indicated that protrusion would occur again at the same or another level. Most of the unsatisfactory results (other than recurrence of protruded disc) were such that spine fusion would not have improved them.

The authors therefore conclude that there are no criteria for spine fusion following removal of a protruded nucleus.—*R. S. Bromer, M.D.*

DU TOIT, J. G., and FAINSINGER, M. H. Spinal extradural cysts. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 613-618.

In this paper, two types of spinal extradural cysts are discussed: (1) the type which occurs in adolescents in the dorsal spine with evidence of kyphosis juvenilis; (2) the type which occurs in adults in the dorsolumbar spine without kyphosis. A case of dorsolumbar spinal dural cyst is reported, the patient having no deformity. Roentgen examination of the middle and upper dorsal vertebrae showed no abnormality. The lower and upper lumbar vertebrae showed definite changes. In the lateral film the vertical interpeduncular spaces were increased and the anteroposterior view showed flattening and atrophy of the medial aspects of the pedicles. The interpeduncular distances showed irregular variation in place of the normal regular increase in the caudal direction. The tenth and eleventh dorsal and the first and second lumbar vertebrae showed abnormal measurements. In the lateral projection there was marked hollowing of the posterior surfaces of the bodies, particularly from the tenth dorsal to the third lumbar vertebrae. Narrowing of the pedicles in the vertical diameter, with consequent enlargement of the intervertebral foramina, was also evidence in this view. These findings were interpreted as indicating the presence of a large mass within the spinal canal, extending from the tenth dorsal to the third lumbar vertebrae and causing pressure changes in adjacent bone. Myelography showed enlargement of the neural canal. The opaque medium passed beyond the

normal confines of the spinal theca and through the intervertebral foramina. The passage of globules of lipiodol beyond the lateral limits of the neural canal suggested recesses, or diverticula, communicating by means of a narrow neck with the sub-arachnoid space.

Laminectomy showed three large cysts, each containing clear colorless fluid. They were thin walled and, except at the exit of two nerve roots where the cysts were closely adherent, could easily be dissected off the dura. The spinal canal was found to be much widened. After operation, the spasticity of the right lower limb which the patient had, disappeared rapidly and that of the left lower limb more slowly. When last seen she was walking well without assistance, and although there was some valgus deformity of the left foot, she considered that her recovery was complete.

The origin of spinal extradural cysts has not been established finally. This case, the authors think, supports the hypothesis that the extradural cyst is due to a congenital diverticulum of dura mater or to a herniation of the arachnoid through a congenital defect in the dura. It would seem that there is a tendency for the lumbar extradural cysts to become manifest at a later age than dorsal cysts. A likely explanation is that the lumbar canal is spacious and the cauda equina is readily displaced, so that cysts may grow without giving rise to symptoms for a longer period in the lumbar spine than is possible in the dorsal region.

It has been suggested that kyphosis dorsalis juvenilis may be the result of venous congestion and stasis in these vertebral bodies, whatever the cause of the vascular disturbance. This suggestion is not supported by the fact that there was no vertebral deformity in the 4 previously reported cases of lumbar cysts.—*R. S. Bromer, M.D.*

ZADEK, ISADORE, and GOLD, AARON M. The accessory tarsal scaphoid. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 957-968.

In this article, the authors use the term "accessory tarsal scaphoid" (navicular) to indicate that accessory element which is juxtaposed medially and posteriorly to the tubercle of the tarsal scaphoid. It often gives the appearance of an extension of the scaphoid bone rather than resembling the other accessory scaphoid elements of rare occurrence, such as the os supranaviculare, the os infranaviculare or the true bipartite scaphoid.

The authors were fortunate to find children and adolescents whose roentgenograms showed accessory scaphoids; these patients were re-examined, both clinically and roentgenographically, at intervals of one to eight years after the original roentgen examinations. Eight such cases, representing fourteen accessory scaphoids were studied with follow-up examinations.

The roentgenograms of the fourteen accessory scaphoids showed that definite fusion between the accessory scaphoid and the scaphoid bone occurred in five instances, partial fusion occurred in three and there was failure of fusion in six.

Microscopic studies of the accessory bones removed showed that the accessory scaphoid and the scaphoid bone, having the usual cancellous trabecular structure of tarsal bones, were joined by a layer of soft tissue. This soft tissue plate consisted of hyaline cartilage, dense fibrocartilage, or a mixture of the two. The plate varied in thickness, was occasionally beset with longitudinal or transverse clefts, and frequently showed very active ossification on each side. In none of the cases studied was a well developed, freely movable joint found, with smooth hyaline articular cartilage capping each bone, and with the two articulating bones found together by a synovial-lined fibrous capsule such as one would expect to find in the talonavicular joint. The specimens frequently exhibited evidences of trauma in the form of hemorrhages, organizing fibrous tissue containing giant cell osteoclasts and chondroclasts and callus-like reparative tissue located subchondrally. The authors think this explains the acute symptoms and localized pain often found in patients with an accessory scaphoid.—*R. S. Bromer, M.D.*

HARRIS, R. I., and BEATH, THOMAS. The etiology of peroneal spastic flat foot. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 624-634.

The authors state that peroneal spastic flat foot is a term loosely and often inaccurately used to describe rigid valgus feet developing from widely different causes. The most common causes are two anomalies of the bones of the tarsus, the calcaneonavicular bar, and the talocalcaneal bridge. The first has been described. The second is described for the first time in this paper as an etiological factor in rigid flat foot though it has been recognized by anatomists for fifty years as a skeletal variation. The term peroneal flat foot, as applied in these cases, is

inaccurate since there is no spasm of the peroneal muscles. The deformity is a fixed structural deformity due to anomalous bone structure, and the apparent spasm of peroneal muscles is in reality an adaptive shortening. A better term would be rigid flat foot due to talocalcaneal bridge or calcaneonavicular bar. Roentgenograms demonstrating these variations are included in the paper.

The smaller group of patients who suffer from inflammatory lesions of the tarsal joints, chiefly due to rheumatoid arthritis, do in fact develop valgus deformity from peroneal spasm. The resemblance between the two groups is superficial and it is limited to the apparent similarity of the deformity. Though it might be justifiable to designate this type as peroneal flat foot, the authors think it would be better to use the more accurate title—arthritic flat foot with peroneal spasm.

Lipping of the upper margin of the talonavicular joint strongly suggests the existence of one or other of the congenital anomalies. Both anomalies are visualized only by special roentgenographic projections, lateral and postero-superior oblique views.—*R. S. Bromer, M.D.*

FAIRBANK, H. A. THOMAS. Dyschondroplasia. Synonyms—Ollier's disease, multiple enchondromata. *J. Bone & Joint Surg.*, Nov., 1948, 30-B, 689-708.

This paper is part of an Atlas of General Affections of the Skeleton. In it the hereditary and familial influences, sex and age incidence, etiology, distribution, clinical signs, roentgenographic appearances, progress and complications, pathology, and diagnosis of dyschondroplasia are discussed. The roentgenograms which are reproduced show the changes of the condition very clearly.

Fairbank states that the condition is often linked with diaphyseal aclasis or multiple cartilaginous exostoses. The two conditions are regarded as variants of the same fundamental developmental error. This, he thinks, may lead to confusion which, however, is quite unnecessary. Although both result from a fault of the epiphyseal line, nests of cartilage becoming misplaced instead of calcified and ossified in the normal manner, they are roentgenologically and in other ways quite different and in the vast majority of cases are readily distinguishable. In the condition to which he prefers to confine the term dyschondroplasia, masses of cartilage are found inside the metaphyses, the lesions being

endosteal and not projections on the surface, as are exostoses.

There is a strong tendency towards unilateral distribution of the lesions, though seldom strictly so. Fairbank thinks there seems to be no sufficient reason for linking the condition of striated bones reported by Voorhoeve (1924) with dyschondroplasia and osteopoikilosis, as suggested by that author. He believes the association of enchondromata and exostoses in the same case is very rare, in fact much more rare than some authors would indicate. In younger children, the epiphyses usually show no abnormality, but in older children, even from five years upwards, irregularity in density with mottling and occasionally streaking of some epiphyses may be seen in the roentgenograms. In the adult, abnormal streaking still visible in the shaft of a bone may be seen to extend into what was the epiphysis. As a rule there is little tendency, except in the hand and foot, for the masses of misplaced cartilage to proliferate. In the fingers, the presence of many enchondromata of considerable size, fungating through the cortices, may eventually cause complete crippling of the hand. In a major long bone proliferation of an endosteal nest of cartilage occasionally continues after growth has ceased, but this is very unusual. Even more rare is the development of a chondrosarcoma. It is not always easy to determine whether such a growth has arisen endosteally, or started in the cartilage cap of an exostosis. The latter appears to be distinctly the more common of the two.

The diagnosis is usually easy when roentgenographic surveys of the skeleton have been made. Films of the digits are particularly helpful in doubtful cases. Maffucci's syndrome is a condition in which dyschondroplasia is associated with cavernous hemangiomas and phleboliths in soft tissues. Very few cases of this syndrome have been reported. Carleton in 1942 reported 2 cases and found only 20 others in the literature.

Included in this article is a discussion of metaphyseal dysostosis. This is an excessively rare condition in which the metaphyses of all long bones consist for the most part of unossified cartilage. The roentgenographic appearances are unique and they differ considerably from those seen in dyschondroplasia. Changes in the hands differ strikingly from those of dyschondroplasia; the cartilage masses, dotted with fragments of bone, are seen only adjacent to every epiphysis and they are not distributed

irregularly as isolated enchondromata anywhere in the shafts of the metacarpals and phalanges. The carpus of the only case which could be found reported in the literature seemed to be ossified normally, likewise much of the tarsus, but the posterior portion of the os calcis showed changes similar to those in a metaphysis. In the metaphyses of the long bones there were spots of calcification and ossification varying in size, shape and density. Many of them seemed to be enlarged. There were wide intervals between the shafts and the epiphyses, the spaces containing varying numbers of rather dense and discrete centers of ossification. The epiphyses were not mottled. The skull, spine, ribs, and clavicles appeared to be ossified in normal fashion.—*R. S. Bromer, M.D.*

SHERMAN, MARY S. Estrogens and bone formation in the human female. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 915-930.

In a woman of fifty-eight years, many of whose bones had almost disappeared as a result of Paget's disease, together with a severe postmenopausal osteoporosis, massive estrogen therapy was followed almost at once by a remission of clinical symptoms and by actual reconstitution of bone.

Albright and his associates studied postmenopausal osteoporosis as a hormonal deficiency and found that they could produce and maintain calcium retention in the human being by the injection of estrogens. These metabolic effects were accompanied by a satisfactory improvement in symptoms. The interpretation offered by Albright is that osteoporosis is a disorder in which the etiological factor is a hypofunction of the osteoblasts in producing bone matrix. In some fashion, not yet clearly understood, estrogens are assumed to stimulate the osteoblasts, so that the process of ossification can proceed normally. Albright and his co-workers admitted, however, that irrefutable evidence that the bones actually became denser has never been obtained by them or by others. In the case reported by the author in this paper, actual reconstitution of bone occurred.

Withdrawal of the estrogen produced an exacerbation of the condition; its readministration was again followed by improvement. For over two years the patient has been kept on daily doses of from 2,000 to 10,000 rat units (0.33 to 1.66 milligrams) of estradiol benzoate. During this time she has maintained her improvement and has showed no untoward symp-

toms. There was no evidence, either clinical or roentgenographic, of a tendency of the bone to absorb except when estrogen was discontinued.

Paget's disease of bone is accompanied by an increased circulation. Thus it is conceivable that the ordinary process of postmenopausal atrophy, when it evolves in a bone which is already the site of an active Paget's disease, is greatly augmented both in rapidity and in degree.—*R. S. Bromer, M.D.*

VANDEMARK, WALTER E., and PAGE, MANLEY A. Massive hyperplasia of bone following fractures of osteogenesis imperfecta. *J. Bone & Joint Surg.*, Oct., 1948, 30-A, 1015-1017.

Two cases of osteogenesis imperfecta are reported in which an osseous mass developed at the fracture site, expanding in all directions. This was accompanied by local heat, redness, pain and tenderness, and, in the one case seen in the acute stage, by systemic fever. In both cases, the question of malignancy was raised by consulting orthopedic surgeons. In the first case a biopsy was performed, five months after the fracture of the humerus had occurred. Both patients had definite osteogenesis imperfecta.

The exact nature of the process is obscure at present. It would appear to indicate a quantitatively exaggerated repair reaction of osteoblasts whose qualitative defect characterizes this bone dysplasia.—*R. S. Bromer, M.D.*

GENERAL

ARCHER, VINCENT W., COOPER, GEORGE, JR., and ADAIR, NORMAN. Symptoms masked or modified by chemotherapy. *J.A.M.A.*, Oct. 30, 1948, 138, 645-650.

During the past few years members of the Department of Roentgenology of the University of Virginia Hospital have been impressed by the increasing number of patients with diagnostic difficulties following chemotherapy in whom the symptoms did not fit in with the roentgen findings. The authors found this to be particularly true in surgical complications such as abscess of the lung and infected bronchiectasis resulting from pneumonia.

Fourteen illustrative cases of varied conditions are presented, with symptoms and signs at variance with the roentgenologic and operative findings. The type of cases in which symptoms were markedly altered by chemotherapy include the following conditions: (1) diverticulitis with cancer, (2) fibrosarcoma, (3) peri-

nephritic abscess, (4) lung abscess, (5) acute cholecystitis, (6) mastoiditis, (7) subphrenic and subhepatic abscess, (8) empyema and (9) osteomyelitis.

In conclusion, the authors state that "the roentgenologist must accept an increasingly large share of the responsibility for correct evaluation of progression or regression of pathologic processes due to infection when treated by chemotherapy."—*R. F. Niehaus, M.D.*

PESKIN, A. ROBERT. Increased sugar tolerance as a factor in the production of a symptom complex simulating peptic ulcer, neurocirculatory asthenia and psychoneurosis. *Am. J. Digest. Dis.*, March, 1948, 15, 92-101.

Four cases are presented in which vague symptoms of a bizarre character were experienced for four years. In some, there was a family history of similar complaints. These symptoms were: hunger pains relieved by food, nervousness, apprehension, weakness in the legs, tremors, excessive perspiration, and mental dullness. The symptoms were aggravated or precipitated by physical effort and were prevented or relieved by eating and rest. The similarity of the group of symptoms to symptoms associated with peptic ulcer, neurocirculatory asthenia, or psychoneurosis is discussed. The disclosure of the true cause for these symptoms, by a study of the sugar tolerance, suggested itself from the similarity of these symptoms to those of hypoglycemia. Study of the blood sugar level at which symptoms of mild hypoglycemia occurred revealed that these patients displayed symptoms at a relatively high sugar level. Confirmation of the observation that these patients' symptoms were due to relative hypoglycemia was revealed by reproduction of the same symptoms with insulin and exercise. At a relatively high blood sugar level (88 mg. per cent) one patient began to have symptoms of tremor, air hunger and peculiar discomfort in the pit of his abdomen. More severe symptoms were evident at 74 mg. per cent. A disappearance of symptoms took place with the administration of orange juice. The value of high fat and protein diet in the prevention and relief of this metabolic disturbance is discussed. The practical value of the search for this entity in such obscure cases as neurocirculatory asthenia, psychoneurosis, and peptic ulcer syndrome without positive roentgen findings, is discussed. These patients disclosed mild liver and thyroid

dysfunction. The concept that mild symptoms of hypoglycemia may appear at a relatively high sugar level is stressed.—*Franz J. Lust, M.D.*

BRODSKY, EDWARD. Income-sharing formula; basis for paying part time pathologists and radiologists. *Hospitals*, March, 1948, 22, 35-37.

After a survey of 84 hospitals in the New England area, the author worked out a formula that sets a fair ratio between part time and full time earnings, both in part time and full time arrangements. This article summarizes the more complete edition available in the Bacon Library. Two of the charts suggested as a basis for reimbursement are shown. The original article is worth reading for those interested in a basis for payment equitable to each party.—*George H. Ramsey, M.D.*

ROENTGEN AND RADIUM THERAPY

TRUSLER, HAROLD M., and BAUER, THOMAS B. Keloids and hypertrophic scars. *Arch. Surg.*, Oct., 1948, 57, 539-552.

A hypertrophic scar remains confined to area of skin incision or injury but a keloid tends to invade surrounding tissues. Microscopically it is difficult to distinguish them. Trauma to the dermis in susceptible persons is necessary as trauma to the epidermis does not produce keloids. Theories of keloid formation are "hormonal stimulation" and "fibroblastic diasthesis," a fibroblastic response to tissue edema at site of injury. Cutaneous wounds crossing flexion creases and those that heal under tension are most likely to cause keloids. Regional body susceptibility and racial susceptibility are other factors.

All lesions are kept under observation at least three months or longer after healing. Pressure locally for several months may prevent the two conditions. If hypertrophy occurs roentgen therapy is instituted. If already formed, excision plus radiation are used. Most cases are given radiation (kv., distance, etc. not given) using 1 mm. Al. The first dose is $\frac{1}{2}$ erythema dose. In two weeks this is repeated. Subsequent treatments are at monthly intervals, unless the scar increases in size. The usual number of treatments is four. If lesions are very large, fractional excision plus irradiation is used. The importance of successful skin grafting is emphasized.—*Thomas L. Martin, M.D.*

KIMBROUGH, ROBERT A., and MUCKLE, CRAIG W. The treatment of carcinoma of the cervix. *Am. J. Obst. & Gynec.*, Oct., 1948, 56, 687-693.

High voltage roentgen therapy precedes the application of radium in the treatment of carcinoma of the cervix in most clinics today. There are four advantages to this method: The malignant cells are devitalized before local manipulation is carried out; the lymphatics are partially sealed; the local infection is cleared, and there is restoration of the anatomic relationships.

One anterior and one posterior 15 by 15 cm. field port is treated with 2,000 to 2,800 roentgens, in air, at the Pennsylvania Hospital, Philadelphia. Bladder and bowel protection is achieved by placing a lead strip 4 cm. wide and 5 mm. thick in the midline. The depth dose to the midline structures is reduced by 50 per cent beneath the lead strip.

More recently, external irradiation has been supplemented by cervical irradiation through an intravaginal cone.

Six weeks after the completion of the roentgen therapy, radium is introduced into the cervical area, the uterine cavity, and the bases of the broad ligaments. The approximate dose is 6,000 milligram-hours. The patient is kept in the Trendelenburg position in order to protect the intestinal tract during the time the radium is in place.

The authors believe that all patients should be given the maximum amount of radiation therapy, because the end results are nearly equal in highly sensitive, more malignant type and the resistant, more slowly growing type of tumor. The extent of the disease is the only aid in prognosis.

Recently, there has been a return to the Wertheim operation combined with Taussig's lymphadenectomy for the treatment of early selected cases in several of the clinics. Meigs' reasons for advocating this method are as follows:

1. If the cervix is removed, there is no chance for recurrence in it.
2. If the cervix is removed, no cancer can grow in it as a recurrence.
3. Certain cancers of the cervix are radiation-resistant.
4. From the work of Bonney and Taussig it has been proved that about 20 per cent of patients with lymph-gland involvement can be salvaged by surgery.

This method is restricted to good operative risks by those who advocate it. It is not applicable in patients with parametrial invasion. Meigs reported in 1946 that 77.7 per cent of 36 patients so operated on were living more than three years later.

The authors believe that enough time has not elapsed to permit comparison of the surgical and radiation methods of treatment of carcinoma of the cervix.—*Mary Helen Cameron, M.D.*

MACFARLAND, CATHARINE, STURGIS, MARGARET C., and FETTERMAN, FAITH S. Control of cancer of the uterus. *J.A.M.A.*, Nov. 27, 1948, 138, 941-943.

Among 1,319 supposedly healthy volunteers for periodic pelvic examination, there were 3 squamous cell cancers of the cervix and 1 cancer of the uterine body detected on the first examinations.

For ten years, 742 of these women who were initially thirty to eighty years of age were followed more or less regularly. During the ten years, 1 adenocarcinoma of the cervix, 1 adenocarcinoma of the endometrium, 1 malignant cystic tumor of the ovary and 1 cancer of the anterior vaginal wall were discovered. In addition, 214 inflammatory lesions of the cervix were eliminated after discovery and 193 myomatous tumors of the uterus were recognized. It is concluded that every parous woman of thirty years or more in age should be examined once a year and that inflammatory lesions should be eliminated.—*John Turner, M.D.*

COSTOLOW, WILLIAM E. Management of Stage I carcinoma of the cervix uteri. *Ann. West. Med. & Surg.*, Nov., 1948, 2, 506-509.

The author feels it is important to reconsider the management and results of treatment in Stage I carcinoma of the cervix since, while presumably curable in a high percentage of cases, about 1 patient in every 5 dies before five years have elapsed. Improvement in results depends upon utilization of more perfect methods of delivering adequate radiation, plus careful attention to important factors such as evaluation of stage of disease, with possibility of unrecognizable metastasis, histopathological grading, presence or absence of infection, and character of blood supply to the tumor bed.

In the authors group, 13 per cent (105 cases) of 2,173 cases of cervical cancer since 1922, were classified as Stage I; 82.9 per cent of the cases

treated between 1922-1943 survived five years free from clinical evidence of disease. Seventy cases were available for ten year follow-up and 60 per cent of these survived without evidence of disease. During the second five year period about 9 per cent of patients died of recurrence and a small proportion died from causes other than cancer of the cervix; the chief loss in material during this second five year period is due to loss from follow-up. He estimates that, were it possible to project the same factors for follow-up in the second quinquennium as applied patients in the first, the survival rate should be about 74 per cent after ten years. It should be emphasized, therefore, that the five year survival should not be considered a criterion for absolute cure.

Since it has been shown that regional metastasis has already taken place in 25 to 50 per cent of operable Stage I cases, external roentgen therapy is an important adjuvant of intracavitary radium. Present external roentgen therapy in his group consists in the delivery of 3,500 to 5,000 r by 500 kv. apparatus in addition to intracavitary radium. He considers treatment by 3,000 milligram-hours intracavitary radium wholly inadequate.

Disadvantages of surgery alone are that the patient must be highly selected with exclusion of many because of constitutional reasons, and that the surgical procedure must be more extensive than the original Wertheim procedure. The mortality from such type of operation is low because of modern advances in anesthesia, physiology, and chemotherapy. He quotes Meigs, "At this time radiation is the proper treatment for cervical cancer. There will be no proof of the efficacy of modern American Surgery until a five-year report of 100 cases is made. Such a report will not be available until July, 1951." Surgical approach, combined with radiation therapy (Garcia and Menville) shows a definite advantage over surgery alone, and may be of particular use in cases not well handled by irradiation alone, such as Stage IV, in which the bladder and/or rectum must be sacrificed. Interstitial implantation of weak radium needles (Pitts and Waterman) requires individualization of cases, but permits radical radiation therapy with minimum destruction of normal structures and has given excellent results.

Costolow states that a pelvic wall dosage of 5,000 gamma roentgens may be delivered safely. Of the recently developed radium ap-

plicators, he feels that that developed by Ernst supplying multiple foci of radium about the cervix permits a larger safe dosage. The miniature "bomb" of Neary requires special heavy metal protection of the rectum and bladder.—*Angus K. Wilson, M.D.*

HALL, JOHN W., and FRIEDMAN, MILTON. Histologic changes in squamous-cell carcinoma of the mouth and oropharynx produced by fractionated external roentgen irradiation. *Radiology*, March, 1948, 50, 318-350.

A detailed study of histopathological changes produced by fractionated external irradiation in squamous cell carcinoma of the mouth and oropharynx was made in 28 cases. Treatment was given with 200 kv. roentgen rays, 0.5 to 2 mm. Cu filter and a daily skin dose of 400 r (with backscatter). The average daily tumor dose was 275 r, and total tumor dose 6,000 to 6,500 r in twenty-three to twenty-eight days. Periodic biopsies were made during treatment.

Three major types of histopathological changes were noted. They were acute cell death, progressive enlargement to giant-sized tumor cells and radiation keratogenesis. Acute cell death was the most common radiation effect noted. It may occur twenty-four to forty-eight hours after the first treatment, and proceed so rapidly that by the seventh day 50 per cent or more of the tumor cells may have disappeared. The remaining less sensitive tumor cells undergo progressive enlargement. They become most numerous toward the end of the second week and usually disappear completely by the end of the seventh week. Tumors showing pleomorphism have a greater tendency toward giant cell formation during treatment.

The third mechanism whereby normal squamous epithelium and squamous cell carcinoma are destroyed by irradiation is through radiation keratogenesis, the acceleration in rate or degree of the normal process of keratinization. This is a destructive mechanism seen in varying degrees in most irradiated squamous cell carcinomas, and in an occasional tumor is the dominant mechanism. Radiation keratogenesis was most prominent in tumors showing slight to moderate keratinization.

Connective tissue seems to play little if any part in destruction of tumor cells. The changes are largely replacement fibrosis. No conclusions

could be drawn regarding relation between tumor sensitivity and vascular damage.

A single biopsy between the seventh and eleventh day will often demonstrate the effectiveness of the particular technique sufficiently early to permit its alteration if necessary. At this time 25 to 50 per cent of cells were found to be destroyed, and if destruction is most efficient, most of the destruction will have occurred by acute cell death. The common practice of avoiding severe local and general reactions by reducing the daily dose and extending treatment over a long period is inefficient. The tumor may mature and become more radioreistant.—*S. Friedman, M.D.*

HAMANN, ANNA. External irradiation with roentgen rays and radium in the treatment of human leukemias, lymphomas, and allied disorders of the hemopoietic system. *Radiology*, March, 1948, 50, 378-386.

The results of treatment of 337 cases of leukemia, Hodgkin's disease, lymphosarcoma and polycythemia rubra vera are reviewed.

Patients with generalized disease were given the minimum doses necessary to produce a remission. In local manifestations of Hodgkin's disease and lymphosarcoma a tumor dose of 2,000 to 4,000 r was delivered. All patients were treated with 135 kv. or 200 kv. therapy. Total body irradiation was used in patients with advanced disease with decreased response to local irradiation.

Results of Treatment

Chronic myelogenous leukemia: Six of 49 patients lived over five years with an average survival of six years and five months. The average survival of 35 patients followed until death was thirty-three months.

Chronic lymphatic leukemia: Eight of 51 patients lived over five years. The average survival of 30 patients, followed until death, was thirty months. In elderly people chronic lymphatic leukemia frequently pursues a relatively benign course and 7 of the 8 five year survivors were over fifty years of age at the onset of the disease. Patients with lymphatic leukemia require less irradiation for control of symptoms than those with myeloid leukemia.

Acute leukemia: All patients died within three months after the onset of symptoms regardless of treatment.

Lymphosarcoma: Three of 77 patients lived

longer than five years. Only 12 per cent lived over three years.

Hodgkin's disease: Seven of 143 patients lived for more than ten years and 26 lived for five years or more.

Polycythemia rubra vera: The results of roentgen therapy are not very gratifying with the conventional dosage. In only 1 patient who received the high surface dose of 600 r over each of ten bones was a remission of eleven months observed. A second course with conventional dosage was much less effective. Relatively high roentgen-ray doses are required for effective treatment of polycythemia and such doses cannot be repeated frequently without risk.—*Howard R. Crews, M.D.*

SPURR, CHARLES L., SMITH, TAYLOR R., and JACOBSON, LEON O. Chemotherapy in human lymphomas, leukemias, and allied disorders of the hemopoietic system. *Radiology*, March, 1948, 50, 387-394.

Over a four year period nitrogen mustard was used in a variety of malignant diseases affecting the hemopoietic system. Daily doses of 0.1 mg. per kilogram of body weight were given in courses of four injections on consecutive days. The immediate toxic reactions consist of nausea and vomiting which usually disappears within two or three hours. Peripheral blood changes consist of lymphopenia, leukopenia and thrombocytopenia. There is evidence of regeneration of the myeloid and erythroid by the end of the third week and the marrow returns to normal in approximately eight weeks.

In a group of 40 patients with Hodgkin's disease 14 received nitrogen mustard therapy after extensive roentgen irradiation produced only partial remissions. Seven patients responded well, 2 failed to respond and 5 had remissions of three to ten months with subsequent deaths. These results suggest the value of nitrogen mustard therapy in conjunction with roentgen therapy.

There is a marked variation in the response of lymphosarcoma. Eight patients were treated. Two patients showed no response. Six patients have had remissions with repeated courses for a period of eight to thirty-six months.

Seven cases of polycythemia were treated. The remissions varied from four to twelve months.

There is no indication that remissions were obtained in reticulum cell sarcoma, acute leuke-

mia, multiple myeloma and sympathicoblastoma.—*Howard R. Crews, M.D.*

KARNOFSKY, D. A. Chemotherapy of neoplastic disease. I. Methods of approach. *New England J. Med.*, Aug. 5, 1948, 239, 226-231.

Chemotherapeutic efforts against tumors usually select a vulnerable point in the neoplastic process. Colchicine attacks the cell in mitosis, estrogens affect tumor cell environment, Shear's polysaccharide damages tumor blood supply, and radioiodine exerts its selective effect via a selected process in cell metabolism.

Current laboratory study of chemotherapeutic agents utilizes a wide variety of test objects, sample tumors, and in vitro or in vivo methods. Most commonly used are mice bred for high tumor susceptibility. Common mouse test tumors are sarcoma 37, sarcoma 190, and transmitted leukemia.

Response is judged by tumor appearance after treatment, by animal survival times, or by effect on percentage of takes in transplantable tumors. Cytocidal techniques determining dosages needed to destroy transmission viability of tumor cells are also used. Effects of chemotherapeutic agents may also be studied in tumor tissue growing on chorioallantoic chick membrane, or explanted in tissue culture.

Clinical evaluation of chemotherapeutic agents is usually difficult, especially with agents that are palliative rather than curative. Complete coherent critical study of each pharmacological agent is necessary.—*Henry P. Brean, M.D.*

KARNOFSKY, D. A. Chemotherapy of neoplastic disease. II. Trends in experimental cancer therapy. *New England J. Med.*, Aug. 12, 1948, 239, 260-270.

The author enumerates and evaluates those substances which have been reported to be effective agents against tumor growth in recent years. Biologic products such as Shear's polysaccharide, Coley's toxins, K-R, A.C.S., and myelokentric acid are reviewed. The action of folic acid antagonists, adrenocortical hormones, estrogen hormones and related products are discussed.

The basic data on cell poisons such as the nitrogen mustards, urethane, colchicine, and podophyllin is detailed. The potential application of hydrocarbon carcinogens in tumor ther-

apy, and of the radioactive substances now being studied, is discussed. A large number of other compounds are also reviewed in considerable detail, for which the original article should be consulted.—*Henry P. Brean, M.D.*

KARNOFSKY, D. A. Chemotherapy of neoplastic disease. III. Agents of clinical value. *New England J. Med.*, Aug. 19, 1948, 239, 299-305.

Only a few of the many substances potentially valuable in tumor therapy are known to be clinically useful. The author lists those agents which he believes to be of value in the management of patients with neoplastic disease. They are critically reviewed, being listed in order of clinical value as estimated by the author, beginning with estrogen therapy and orchidectomy for prostatic cancer. Indications, preparations of choice, modes of administration, and toxicity are described for each agent.

Other agents reviewed are, in order of estimated value, nitrogen mustard, radioactive iodine, androgens in cancer of the breast, radioactive phosphorus urethane, and Fowler's solution.—*Henry P. Brean, M.D.*

DONNELLEY, GRACE C., and BAULD, A. G. Aspects in the treatment of vulvar and cervical carcinoma. *Am. J. Obst. & Gynec.*, Sept., 1948, 56, 494-501.

Review of female pelvic malignancies from 1926 to 1945 in the Radium Clinic, Royal Victoria Maternity Hospital, Montreal, and the Department of Obstetrics and Gynecology, McGill University, revealed three groups of interest. These groups are carcinoma of the vulva, carcinoma in the cervical stump, and selected cases of cervical carcinoma treated by irradiation and surgery.

There were 40 cases of carcinoma of the vulva. Prior to 1940, 30 were treated with various combinations of irradiation and surgery or one or the other alone. Subsequent studies indicated that excision or vulvectomy produced more survivals. Two of the 10 remaining cases were treated by diathermy excision and 8 by diathermy vulvectomy. These 10 showed a five year survival of 23.33 per cent. Local recurrences are not common.

No additional treatment was directed to the inguinal nodes unless clinical involvement existed at that time. Metastases occurring later were not uncommon. Recently, this clinic has

been treating the inguinal gland region initially, either by surgery or irradiation.

The main objection to diathermic vulvectomy is the subsequent slow healing.

Forty-eight cases of stump carcinoma were found. Five of these were uterine carcinoma, 3 were associated with pregnancy, and 43 were cervical in origin. A true stump carcinoma is counted as one which occurs two or more years after subtotal hysterectomy. If the period is shorter, the carcinoma is thought to have been present at the time of hysterectomy. Twenty-eight of the 48 total were true cervical stump carcinoma.

Two apparently good results were obtained by surgical removal of the stump following irradiation in patients presenting uterine carcinoma of the stump. In all those cases associated with pregnancy, extensive spread was present. Radium therapy following Porro section produced only one three and a half year survival.

Of the 28 cervical stump cases, 12 probably had carcinoma at the time of subtotal hysterectomy. In 8 of these 12, the lesion was not apparent before operation. Seven were treated with radium and roentgen irradiation and 5 with radium alone. Two are living and well at the end of five years and one at the end of fifteen years.

In the majority of cases, the carcinoma was diagnosed ten or more years after operation, so that it can be assumed the cervix was devoid of carcinoma at the time of surgery.

Thirty-nine per cent of the cases had had bilateral oophorectomy at the time of subtotal hysterectomy, so that it would seem to contradict the theory that carcinoma of the cervix is influenced by ovarian stimulation.

A small group of selected cases, consisting of Stages I and II, and some in Stage III have been subjected to irradiation followed by surgery. The surgery was usually panhysterectomy. Six months elapsed between irradiation and surgery. The late complications and poor results in follow-up were mainly in the Stage III group. The five year survival rate in these selected cases was 75 per cent, or 18 of 24 cases. Ten year survivals indicate that late recurrences may be reduced by this method of treatment.—*Mary Helen Cameron, M.D.*

SPEERT, HAROLD, and PEIGHTAL, THOMAS C.

An evaluation of adjunctive radiotherapy in the surgical treatment of endometrial carci-

noma. *Am. J. Obst. & Gynec.*, Sept., 1948, 56 502-508.

This article maintains that valid statistical evidence is lacking to demonstrate improvements in survival rates when radium or roentgen irradiation or both are used in connection with total hysterectomy in the treatment of carcinoma of the uterine body. There are short reviews of many previously published series together with reasons why the authors believe the statistics therein are not acceptable.

Cases should be classified as early, intermediate, or advanced by pathologic examination. Histopathologic grading should also be done.

End results of various treatment methods are thought not to be comparable unless the groups contain about the same proportions of early and advanced cases, and of low and high histopathologic grading.

One hundred fifty-seven cases were reviewed, the absolute survival of which was 50 per cent. Because the authors' cases did not comply with the above categories, the cure rates were expressed for the clinical stages and pathologic gradings.

An 85 per cent five year cure rate was obtained by hysterectomy alone in the early cases. Preoperative radium or postoperative roentgen irradiation produced no increase in this rate. The same observation was true for histopathologic Grade I cases, with a 91 per cent cure rate.

However, in far advanced cases, a tentative observation is made that the cure rate is twice as high in those patients receiving irradiation in addition to surgery, as in those receiving only surgery. There probably also is benefit in high histopathologic grade tumors by postoperative irradiation.—*Mary Helen Cameron, M.D.*

MUNNELL, EQUINN W., and BRUNSCHWIG, ALEXANDER. Five year end-results of irradiation therapy of cancer of the cervix uteri at the Memorial Hospital. *Surg., Gynec. & Obst.*, Sept., 1948, 87, 343-348.

It is the purpose of this paper to present the five year end results in 1,072 patients with cancer of the cervix seen at Memorial Hospital in the period 1934-1941 inclusive. The five year overall cure rate for the 1,037 patients treated by irradiation was 28.6 per cent.

The conclusion to be drawn from these studies is that there appears to be little consist-

ent amelioration in results of the management of carcinoma of the cervix during the years studied. A perusal of reports concerning the results of radiation therapy for carcinoma of the cervix carried out in widely scattered centers leads to a similar impression. It therefore follows that the question must be raised as to whether or not the exclusively radiotherapeutic management of cervix carcinoma should continue to be pursued without some form of combination with surgical attack. The continued repetition in standard texts, even of recent date, that radical hysterectomy for cervix carcinoma is accompanied by a high mortality rate has been a strong influence in discouraging surgical attempts in this field. However, Meigs has shown that modern surgical effort in an appreciable series of selected patients should not entail significant mortality and therefore the argument of mortality does not now have the force which it did two decades or more in the past.

The problem is not one of radiation therapy versus surgery; it is: what can be done to increase progressively the incidence of cure in carcinoma of the cervix uteri?—*Mary Frances Vastine, M.D.*

KARDASH, THEODORE. Sarcoma of the uterus; report of two cases with generalized metastasis. *Am. J. Obst. & Gynec.*, Sept., 1948, 56, 566-573.

Sarcoma of the uterus is rare. It constitutes 1.7 per cent of uterine malignancies. From 1937 to 1946, eight cases in addition to the 2 reported in this article have been seen. Of these, 3 were primary, and 7 were secondary to uterine myoma. Eight were in white patients and 2 in Negroes. The diagnosis was not made preoperatively in any instance, probably due to the varying symptomatology. Nine had palpable masses on admission.

Five patients were subjected to supravaginal hysterectomy; 1 to panhysterectomy; 1 to laparotomy; 1 to dilatation, curettage, and radium; 1 to dilatation, curettage and roentgen irradiation, and 1 to irradiation alone.

Six of the patients died of malignancy within three months of admission. One died of cardiac disease twenty months after surgery. Three are alive and without symptoms; the length of time is not stated.

To improve results, the author suggests that (1) enlarging fibromas and those causing symp-

toms be removed, (2) roentgen examination of the chest be done in suspected cases as blood borne metastases are early and frequent, and (3) specimens be opened at the operating table and rapid section done on suspicious areas.

Two cases of uterine sarcoma with metastases are presented in entirety.—*Mary Helen Cameron, M.D.*

SAUER, HANS R., MACMANUS, JOSEPH E., and BLICK, MICHAEL S. Primary malignant neoplasms of the vesicovaginal septum. *Cancer*, Sept., 1948, 1, 419-426.

This rare tumor is reported by the authors with a brief review of the few references in the literature. Nonepithelial tumors in this location seem to present an unusually confusing histopathological picture.

A group of pathologists reviewing the same slide gave the following diagnoses:

- (1) Carcinoma simplex—low grade.
- (2) Malignant epithelial tumor.
- (3) Renal cell carcinoma.
- (4) Metastatic adenocarcinoma.
- (5) Carotid body like tumor.

It is the authors' opinion that these tumors are usually mixed and contain both radioresistant as well radioresponsive elements. They thus conclude that irradiation can offer nothing but palliation and that extreme radical surgery offers the only possibility of cure.—*W. E. Childs, M.D.*

ORMOND, J. K., and BEST, J. W. Prognosis of testicular tumors. *J. Urol.*, Aug., 1948, 60, 272-279.

This report is based on a series of 40 cases of malignant tumors of the testicle seen at the Henry Ford Hospital between 1923 and 1946. During these years approximately 500,000 patients were seen in the hospital, indicating the rarity of the condition.

The authors suggest the following classification;

- A—Teratoma (Heterologous)
 1. Mixed tumor or adult teratoma.
 2. Embryonal carcinoma.
- B—Seminoma (Homologous)
- C—Interstitial cell tumor

Metastases occur early, usually by way of the lymphatics to the periaortic nodes, the regional nodes, and to the chest by way of the subdiaphragmatic and mediastinal nodes. There is

no direct lymphatic route from the testicle to the superficial inguinal nodes.

The authors divide their 40 cases into two groups; Group I comprising 8 cases, includes all patients thirty years or less of age, and Group II includes the remaining 32 cases, over thirty years of age. The average age was 37.8 years.

The commonest complaint was of painless gradual testicular enlargement. The duration of symptoms was shorter in the younger age group. Other symptoms included local pain and pain due to metastases, and hematuria. Only 10 per cent had a history of trauma. In the authors' series the hormone test was of no value in diagnosis or prognosis.

Of the authors' series 47.6 per cent were embryonal carcinoma, 20 per cent were teratoma, and 15 per cent seminoma; 35 per cent had metastases when first seen. The retroperitoneal nodes, mediastinal nodes and lung fields were the usual sites of metastasis.

Five cases of Group I had metastases when first seen. All were treated by orchiectomy and postoperative roentgen therapy. Four are known dead and the fifth in a terminal condition, at the last consultation.

Nine patients from Group II had metastases when first seen. Of these 7 are known dead and the other 2 terminal.

The treatment of choice is orchiectomy, high ligation of the cord, and postoperative deep roentgen therapy.

Of the 26 cases who had no known metastases 17 have survived for over three years. The authors have had no deaths after the first year of patients presenting without demonstrable metastases and treated by orchiectomy and postoperative roentgen therapy—*Rolfe M. Harvey, M.D.*

LEUCUTIA, T., EVANS, WILLIAM A., and COOK, JAMES C. Radiation therapy of malignant tumors of the testis. *Radiology*. Aug., 1948, 51, 177-187.

Excellent review of the literature with addition of 110 well documented cases. Treatment of the authors' cases was largely simple orchiec-

tomy followed by extensive irradiation. Age grouping followed other investigators' reports. Seminoma occurs at a slightly older age than malignant teratoma. Trauma was significant in these cases by calling attention to the tumor early. Duration of symptoms has some effect on results. Early diagnosis helps prognosis. Known metastasis at start of treatment influences the statistics unfavorably. The two year survival rate proved a good prognostic index. Treatment with radiation therapy added to surgery was markedly superior to simple orchiectomy.—*E. C. Baker, M.D.*

HAWLEY, SYDNEY J. Rotation therapy; theory and clinical applications. *Radiology*, August, 1948, 51, 205-213.

In its simplest form, rotation therapy consists of turning the patient slowly (360° per minute) on a turntable with a stationary roentgen therapy tube centered on a deep-seated lesion. By this method it is stated that a higher tumor dose can be given without skin damage, than by the conventional multiple port method of treatment. The author feels that with comparable tumor doses there is less constitutional reaction when rotation therapy is used.

This method is most efficient when the body irradiated is nearly cylindrical with the lesion being treated in the center. For peripheral lesions and irregularly shaped bodies, its advantages are questionable.—*Robert P. Barden, M.D.*

KAPLAN, IRA, I., and ETKIN, SIDNEY I. Treatment of deep-seated malignant tumors with multiple port technic simulating rotation therapy. *Radiology*, August, 1948, 51, 188-204.

Radiation of tumors of esophagus and lung has been difficult. Rotation therapy has been used to get better tumor doses. Therapy through multiple fixed ports will theoretically allow proper tumor dosage. Multiple fields 7 by 15 cm. using the "Demy protractor" for localization have permitted tumor doses of 5,700 to 6,300 r. Case reports are given. This method of irradiation shows promise.—*E. C. Baker, M.D.*



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 62

NOVEMBER, 1949

No. 5

SCREEN INTENSIFICATION SYSTEMS AND THEIR LIMITATIONS*†

By RALPH E. STURM *and* RUSSELL H. MORGAN

BALTIMORE, MARYLAND

I. INTRODUCTION

IN RECENT years, there has developed among roentgenologists a considerable interest in methods by which the brightness of roentgenoscopic screens may be intensified. This interest has been aroused principally by the relatively poor detail provided by present-day roentgenoscopic screens and by the belief that this detail might be materially improved if screen brightness were increased by a factor of several thousand times. The basis for this belief may be found in the investigations of Chamberlain² and Hecht.⁶ Chamberlain has demonstrated that roentgenograms made with roentgenoscopic screens in contact with roentgenographic films exhibit much more detail than the same screens when observed at roentgenoscopy; and Hecht has shown that the human eye when viewing fields having a luminance approaching that encountered in roentgenoscopy (10^{-4} to 10^{-2} foot-lambert) has a visual acuity or ability to perceive detail, of only a small fraction of that occurring under normal lighting conditions (10 to 100

foot-lamberts). Thus it appears that the poor performance of the roentgenoscope may be attributed to deficiencies of the human eye when operating at the low levels of illumination which occur during roentgenoscopy rather than to any inherent imperfections in the roentgenoscope itself and that this performance should be improved if the brightness of the screen were increased to levels at which the eye performs more satisfactorily.

As convincing as the foregoing evidence may be the premise that an improvement in roentgenoscopic clarity will surely follow an increase in the brightness of the roentgenoscopic screen should not be wholly accepted until it is certain that the causes of poor visual acuity which occurs at low levels of illumination will not also influence the performance of any man-made optical device which may be used to intensify screen brightness. It is entirely possible that the limitations of the human eye are caused by factors which also limit all types of optical systems, physical as well as physiologic. If this is the case the use of an

* From the Department of Radiology, The Johns Hopkins University and Hospital. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

† The work described in this paper was supported by a grant from the National Cancer Institute, the National Institute of Health, United States Public Health Service.

intensifying device in conjunction with a roentgenoscope may cause little if any improvement in screen clarity.

Rose¹¹ has recently shown that the performance of the eye at any level of illumination is largely limited by statistical fluctuations in the number of light photons reaching the retina during the observation of an event. Although most individuals are completely unaware that such fluctuations exist, they nevertheless are present to a greater or lesser degree under all viewing conditions and ultimately determine the fineness of structure that can be perceived. They of course do not constitute the only factor which limits visual performance. Such factors as the diameters of the retinal rods and cones also introduce limitations, but, as Rose has demonstrated, these factors only contract the limits already set by statistical theory.

In general, the statistical fluctuations in light intensity which occur at the retina are proportional to the square root of the average number of photons projected on the retina within the storage time of the eye (about 0.2 second). For example, if the eye is observing an object, let us say 1 mm. in diameter at a viewing distance of 20 cm., the number of photons reaching the retina from the object during each 0.2 second will be of the order of one million at normal levels of illumination. Therefore, the average fluctuation in light intensity at the retina from moment to moment will be approximately 1,000 photons or 0.1 per cent of the average light intensity. Now, if the luminance of the object is reduced to levels comparable to that occurring at roentgenoscopy, the effective number of photons reaching the retina within the storage time of the eye may be as small as one hundred. Accordingly, such a number will have an associated average fluctuation of 10 photons or 10 per cent of the average light intensity. Thus when the luminance of an object is reduced, the per cent fluctuation in the rate at which photons arrive at the retina increases.

The effect of this fluctuation will be

evident if one considers the situation that might occur if the 1 mm. object under observation is surrounded by a field having an average luminance 5 per cent greater or less than that of the object; that is, the contrast between the object and the surrounding field is 5 per cent. Under such a condition, if the object is observed under normal conditions of illumination, the 0.1 per cent fluctuation in the light intensity at the retina will not interfere noticeably with the perception of the object. On the other hand, if the luminance of the object is at a level corresponding to that occurring at roentgenoscopy where the fluctuation is of the order of 10 per cent, the object may at one moment appear darker and at the next moment lighter than the surrounding field. Obviously such variation will interfere markedly with the perception of the object.

It will be apparent from the manner in which statistical fluctuations in light intensity influence visual performance that these same fluctuations will also have a profound effect on the ability of any optical system, including roentgenoscopic screen intensifying devices, to record detail. It therefore will be wise for us to investigate carefully the magnitude of this effect before we raise our hopes too high in anticipation of the results that may be achieved with screen intensification.

II. FLUCTUATION THEORY APPLIED TO ROENTGENOSCOPY

It may be difficult for some to understand the bearing which statistical fluctuation theory has on the performance of the roentgenoscope. However, one or two simple examples should quickly clarify this trouble.

If one takes from his pocket a coin and tosses it a large number of times, one may expect the coin to fall *heads* uppermost 50 per cent of the time and *tails* uppermost the remaining 50 per cent of the time. Now, if instead of a large number of tosses one makes, let us say, 100 throws, it will be rather unusual to obtain exactly 50 heads

and 50 tails. Instead, one may perhaps find 58 heads and 42 tails. Also, if the experiment is repeated again and again, the result on the second try may be 47 heads and 53 tails, on the third try, 44 heads and 56 tails, and so on. Although one may expect to obtain on the average an equal distribution of heads and tails, there will be in any given series of throws of the coin a certain amount of fluctuation about that average due to the random nature in which the coin is tossed.

The situation which occurs during roentgenoscopy is not so very different from that prevailing in the coin-tossing experiment. In roentgenoscopy, roentgen-ray photons are projected through the various anatomical structures under examination. Under usual roentgenoscopic conditions, the number of photons is of the order of 10 million per second for each square millimeter of exposed surface of the patient's body. If it is the abdomen that is under examination about 1 per cent or 100,000 of these photons each second emerge on the average to fall on the roentgenoscopic screen. Now the absorption of roentgen-ray photons within the human body is almost surely a completely random phenomenon; that is, there is a certain probability that the tissues will absorb a given photon but there is no certainty that they will do so. Therefore, if one actually measures the number of photons emerging from each square millimeter of the abdomen each second, one may find 102,000 photons emerging during the first second, 99,000 during the second second, and so on. Or if one takes measurements simultaneously over several similar areas of the abdomen, the readings will fluctuate from one region to another just as the readings fluctuate from time to time within a single region.

Although the knowledge that the number of photons which comprise a roentgen-ray beam fluctuates from instant to instant is interesting, it is of little practical value unless the magnitude of the fluctuations can be determined. In order to derive the formulae by which such calculations may

be made, let us return for a moment to the coin-tossing experiment previously cited. We have seen that when the coin is tossed many times the probability of throwing heads (or tails) is 50 per cent, but that when the coin is tossed a relatively few times, say 100, the number of heads may be only 42; that is, the result shows a deviation from the expected yield. Now if one repeats the experiment of throwing the coin 100 times over and over and on each occasion observes the number of heads that are thrown, a wide variety of values will be obtained that range on either side of the average value of 50. Now one might calculate the average fluctuation of the results of the experiment by adding the various deviations from the expected yield and dividing the total by the number of observations. However, since the number and magnitude of minus deviations below 50 are approximately equal to the number and magnitude of plus deviations above 50, the resultant average would approach zero and therefore give a completely erroneous impression of the size of the fluctuation. For this reason it is conventional statistical practice when calculating average fluctuation to take the various deviations and square them (multiply them by themselves). Under this circumstance, all values become positive. The values are then averaged by adding them together and dividing the total by the number of observations. This result, of course, gives a squared value of the average fluctuation which may be reduced to standard terms by taking its square root.

The value of the average fluctuation derived by this method has been termed by statisticians *the standard deviation*. It is an excellent index of the magnitude of the fluctuations occurring in a random phenomenon and accordingly its use for this purpose has found wide application. Whenever the term standard deviation is used hereafter it will refer to the root mean square value of the average fluctuation as determined by the method just cited.

It may be easily shown by experiment

and statistical theory that the standard deviation or average fluctuation which occurs in a random phenomenon may be calculated from the equation

$$s = \pm \sqrt{npq} \quad (1)$$

where s is the standard deviation,

n is the number of events occurring in the phenomenon,

p is the probability of an event turning out positively, and

q is the probability of an event turning out negatively.

Now in the coin-tossing experiment, the number of throws in each part of the experiment was 100, and therefore in calculating the average fluctuation of the occurrence of heads from equation (1), such a number should be substituted for the symbol n . Also, the probabilities of a coin turning heads and tails are each equal to $\frac{1}{2}$; therefore, p and q in equation (1) have values of 0.5. Thus the average fluctuation in the number of heads should be

$$s = \pm \sqrt{100 \times 0.5 \times 0.5} = \pm 5. \quad (1A)$$

Actually if the experiment is performed, a value very close to 5 will be obtained.

In most roentgen phenomena, the probability of an event turning out positively is rather small. For example, in the roentgen beam projected through a patient's abdomen the probability of an incident photon emerging from the patient's other side is about 1 per cent; that is, there is a 99 per cent chance that the photon will be absorbed or deviated from its course, never to emerge as an image-forming photon. Therefore, under such circumstances, the value of q in equation (1) approaches a value of 1.0 and equation (1) may be written

$$s = \pm \sqrt{np} \quad (2)$$

where n is the number of roentgen-ray photons entering the roentgen phenomenon.

However, np is obviously the number of photons emerging from the phenomenon; therefore,

$$s = \pm \sqrt{n_e} \quad (3)$$

where n_e is the number of emergent photons.

It will be recalled that several paragraphs ago we stated that a typical emergent abdominal roentgenoscopic beam has an average yield of approximately 100,000 photons per second per square millimeter of presenting surface. It will be observed that equation (3) indicates that the average fluctuation associated with such a beam will be 315 photons/sec/sq. mm. or 0.3 per cent.

It may be easily shown that equation (3) is valid whether one speaks of roentgen-ray photons in a roentgen beam, light photons in a light beam, electrons in an electrical system, and so forth. It is the fundamental statistical equation indicating the magnitude of the fluctuations occurring in any random process where the chances of success are small.

Until now, we have considered the fluctuations which occur in simple random phenomena where only a single factor contributed to the deviations. However, in the roentgenoscopic process, fluctuations occur at several different phases of the process and accordingly the simple formula presented in equation (3) is not applicable. In the roentgenoscopic process, the sources of fluctuation are numerous. We have seen how fluctuations occur during the absorption of the roentgen beam in the patient's tissues. Similar fluctuations also occur in the absorption of the beam in the roentgenoscopic screen. Fluctuations arise, too, in the roentgen tube itself. The liberation of electrons from the tube's filament is a random process, and accordingly there will be deviations in the rate at which electrons arrive at the target and produce roentgen rays. Then, too, the production of roentgen rays by electron impacts on the target is a random process; that is, there is a certain probability that an electron will produce a roentgen-ray photon, but there is no certainty that it will do so. Therefore, fluctuations will arise at the instant that roentgen rays are formed. Additional sources of fluctuation occur in the production of light photons by roentgen-ray photons in the

roentgenoscopic screen and in the production of nerve impulses when the light photons fall on the retina. Furthermore, when a screen intensifier is placed in the system several sources of fluctuation may be introduced by the device.

Now these sources of fluctuation in the roentgenoscopic process are essentially independent of one another; that is, the absorption of roentgen-ray photons, for example, in the tissues of the patient has no bearing on the efficiency of roentgen-ray photon production in the roentgen tube. Therefore, it may be easily shown by statistical theory that the average total fluctuation at the termination of the roentgenoscopic process when the nerve impulses are finally transmitted from the retina to the brain is given by the equation

$$s^2 = s_1^2 + s_2^2 + \dots + s_n^2 \quad (4)$$

where s_1, s_2, \dots, s_n are the values at the retina of the various average fluctuations introduced at the various phases of the roentgenoscopic process.

Now the fluctuation introduced at any particular phase of the process is given by equation (3); that is,

$$s_{\pm 0} = \pm n_{\pm}^{1/2} \quad (5)$$

where $s_{\pm 0}$ is the fluctuation at the level of the x phase of the roentgenoscopic process and

n_{\pm} is the number of photons or electrons, as the case may be, observed at that phase.

This fluctuation, of course, will become greater or less as it proceeds through the roentgenoscopic process depending on whether the succeeding stages of the process increase or decrease the process' intensity. For example, the fluctuations produced in the roentgen beam during its passage through an anatomical structure will diminish in magnitude as the beam is absorbed by the roentgenoscopic screen since only a fraction of the beam undergoes screen absorption. Immediately thereafter, however, it will increase in magnitude as each absorbed roentgen-ray photon pro-

duces many light photons and increases the intensity of the process. Now if g_{\pm} is the amplification factor through which the roentgen process passes between the x phase and its final phase within the observer's retina then

$$s_{\pm} = s_{\pm 0} g_{\pm} = \pm g_{\pm} n_{\pm}^{1/2} \quad (6)$$

where s_{\pm} is the value of the retina of the average fluctuation introduced at the x phase of the process.

Equation (6) represents the general expression for each of the terms in equation (4); therefore, equation (4) may be written

$$s^2 = g_1^2 n_1 + g_2^2 n_2 + \dots + g_n^2 n_n \quad (7)$$

But by definition of the term, g ,

$$n_1 g_1 = n_2 g_2 = \dots = n_n g_n = n_n \quad (8)$$

Therefore,

$$s^2 = n_n^2 \left(\frac{1}{n_1} + \frac{1}{n_2} + \dots + \frac{1}{n_n} \right) \quad (9)$$

It will be evident from equation (9) that the value of s will largely be determined by the term which has the smallest value of n . Therefore, equation (9) as a first approximation may be written:

$$s^2 = n_n^2 / n_a \quad (10)$$

where n_a is the smallest value to which the number of photons (or electrons) descends in the roentgenoscopic process.

However,

$$n_a g = n_n \quad (11)$$

where g is the amplification factor through which the roentgen process passes between the stage of n_a to its final stage in the observer's retina, therefore

$$s = \pm g^{1/2} n_n^{1/2} \quad (12)$$

When a quantity of photons, let us say n_n , from an object under observation arrives at and stimulates the retina of an observer within the storage time of the eye, the object will be seen if the number of photons is greater or less by a certain minimum amount than the number of photons

stimulating the retina from the visual field surrounding the object. Rose¹¹ has found that this minimum difference is proportional to the average fluctuation, s , of the number of stimulating photons from the object; that is,

$$\Delta n = ks = \pm kg^{1/2}n_n^{1/2} \quad (13)$$

where Δn is the smallest difference between the number of photons in the retinal image and its surrounding field which allows perception of the image and k is a proportionality constant, which may be conveniently termed the threshold *contrast to fluctuation ratio*.

Now the contrast of an image is usually defined as the ratio of the difference in light intensity between an image and its surrounding field to the light intensity of the image. Therefore the per cent threshold contrast for image perception is given by the equation

$$C = \frac{\Delta n}{n_n} \times 100. \quad (14)$$

When n is eliminated from equations (13) and (14)

$$C^2 = \frac{k^2 g}{n_n} \times 10^4. \quad (15)$$

Now if n_r is the number of stimulating photons which reach the retina from the object each second, then

$$n_r t = n_n \quad (16)$$

where t is the storage time of the eye.

Also, if n_0 is the number of stimulating photons which reach the retina from each square millimeter of the roentgenoscopic screen or pick-up surface of the screen intensifier if such a device is used,

$$n_r = \frac{\pi \delta^2 n_0}{4} \quad (17)$$

where δ is the diameter of the object under observation.

Therefore

$$C^2 = \frac{4k^2 g}{\pi \delta^2 n_0} \times 10^4 \quad (18)$$

or

$$\delta = \pm \frac{2k}{C} \left(\frac{g}{\pi n_0} \right)^{1/2} \times 10^2. \quad (19)$$

Equation (19) specifies the size, δ , of the smallest discernible object and its contrast, C , in terms of (1) the number of stimulating photons, n_0 , which reach the retina each second from each square millimeter of the roentgenoscopic screen or pick-up device, (2) the amplification factor, g , of the roentgenoscopic process between the stage of lowest intensity and the stage at which the retina is finally stimulated, (3) the storage time of the eye, t , and (4) the threshold contrast to fluctuation ratio, k , which the eye will tolerate. It will be seen that when contrast increases the minimum object size that can be perceived becomes smaller; that is, the greater the contrast, the finer the detail that may be seen. Also, when the number of photons stimulating the retina (i.e. the brightness of the scene of observation) becomes greater, the size of the smallest perceptible object diminishes in size. These are of course facts that are well known through experience to everyone.

III. VISUAL PERFORMANCE DURING CONVENTIONAL ROENTGENOSCOPY

If values for the various parameters listed in equation (19) may be obtained for a particular roentgenoscopic system, the ability of that system to record detail at various contrast levels may easily be evaluated. During the past few months we have undertaken in our laboratory a series of investigations by which these parameters have been determined for simple roentgenoscopy, for roentgenoscopy aided by an ideal screen intensifying device, and finally for roentgenography. The values for roentgenography were obtained so that a comparison of the anticipated performance of the ideal roentgenoscopic intensifying system might be made with roentgenographic films. One so often hears the statement that by screen intensification roentgenoscopy may be expected to approach roentgenography in clarity that we deemed it desir-

able to calculate the comparative merits of the two methods.

The first system studied was simple roentgenoscopy itself. The values of g and n_0 in equation (19) were obtained by tracing from the beginning the various phenomena which occur during the roentgenoscopic process.

In simple roentgenoscopy it is customary to operate the roentgen tube at a potential of about 70 kvp., a tube current of 5 milliamperes and with a tube-screen distance of about 27 inches. Also, a filter of 1 mm. of aluminum is usually placed in the roentgen beam.

The number of roentgen-ray photons which are produced under these conditions and which are projected each second toward each square millimeter of the roentgenoscopic screen may be measured in a number of ways. The method which we employed was that in which the number of roentgens per second, produced by the beam at a distance of 27 inches from the tube's target, was measured and applied to the well-known conversion formula

$$N = \frac{32r}{eI' \rho u/p} \times 10^{-2} \quad (20)$$

where N is the number of roentgen-ray photons per second projected on each square millimeter of screen surface,

r is the experimentally measured number of roentgens,

e is the charge on the electron,

I' is the energy in electron volts of each photon,

ρ is the density of air, and

u/p is the mass absorption coefficient of air.

This method of measurement has the advantage that, although the energies of the photons in the roentgen-ray beam extend through a considerable range, no tedious mathematical manipulations are incurred in the use of the formula because the product of $I' \times u/p$ remains relatively independent of photon energy through the range of tube voltages employed in medical

roentgenoscopy. This independence is well shown in Figure 1 where it is seen that in the energy range between 25 and 70 kev., (the energy range of the photons in a beam produced by a tube operating at 70 kvp.) the value of the product is $1.1 \times 10^4 \pm 10$ per cent.

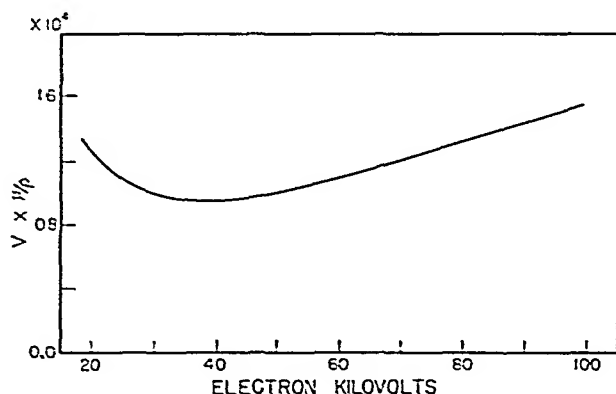


FIG. 1. Curve in which the product of I' , the energy in electron volts of a roentgen-ray photon, and u/p , the mass absorption coefficient of air for that photon is plotted as a function photon energy.

The number of roentgens per second measured at the screen site was 0.088 and therefore 5×10^6 photons per square millimeter per second are delivered to the screen by a roentgen tube operating under the average roentgenoscopic conditions under consideration.

Only a small fraction of the photons projected by the roentgen tube toward the fluorescent screen actually reach the screen since most are absorbed by the anatomical structure under examination.⁸ For example, the chest transmits approximately 10 per cent of the radiation incident upon it while an anteroposterior projection of the abdomen transmits about 1 per cent; and a lateral abdominal projection transmits the extremely low fraction of approximately 0.1 per cent. Therefore, the number of roentgen-ray photons that finally reach the roentgenoscopic screen is governed by the anatomical structure under observation and amounts to 5×10^5 photons per square millimeter per second for chest roentgenoscopy, 5×10^4 photons per square millimeter per second for anteroposterior abdominal roentgenoscopy, and 5×10^3 pho-

tons per square millimeter per second for lateral abdominal roentgenoscopy.

All of the photons that arrive at the screen surface, of course, do not create luminescence; only those that are absorbed may be expected to do so, and even some of these may not be light-producing for a portion dissipate their energy in the production of characteristic roentgen radiation which subsequently may escape from the screen. The possibility of this occurrence in roentgenoscopic screens, however, is not large because the phosphor commonly used in these screens is zinc sulfide, a material whose characteristic radiations are of such long wavelength that they are readily absorbed before they have a chance to escape from the screen. Therefore one can be reasonably sure that almost none of the radiation absorbed by a roentgenoscopic screen leaves the screen as characteristic roentgen radiation.

The roentgen-ray absorption of a fluoroscopic screen is governed, among other things, by the quality of the exposing radiation. Now previous work by one of us⁹ has shown that the radiation quality normally encountered in medical roentgenoscopy and roentgenography extends through the half-value layer range of 1 mm. to 6 mm. of aluminum. For conventional chest fluoroscopy performed at a roentgen tube potential of 70 kvp., the value is approximately 2 mm. of aluminum while for anteroposterior abdominal and lateral abdominal fluoroscopy, the values approach 4 mm. and 6 mm. of aluminum respectively. Absorption measurements made in the laboratory on a Patterson type B-2 screen, the roentgenoscopic screen that is now finding wide use in fluoroscopy, yielded absorption values of 68 per cent, 55 per cent, and 51 per cent at these three radiation qualities. Therefore, the numbers of roentgen-ray photons per second arriving at each square millimeter of the screen's surface and producing illumination are closely 3.5×10^5 , 2.5×10^4 , and 2.5×10^3 for the three types of roentgenoscopy under consideration.

The roentgen-ray photons absorbed by

the screen are of a considerably higher energy level than the light photons that they produce. As a result, one may expect the generation of a considerable number of light photons for each roentgen-ray photon absorbed. The number of light photons produced per incident roentgen-ray photon and projected from the front surface of the screen was determined experimentally for the Patterson type B-2 screen by projecting on it from a distance of 27 inches a roentgen beam generated by a roentgen tube operating at 70 kvp., and 5 milliamperes and filtered by 1 mm. of aluminum. The absorption of the screen under these conditions was 0.6. The energy of the light emitted by the screen per square millimeter per second was then measured by a photoelectric spectrophotometer calibrated in microwatts per sq. mm., and the yield of light photons calculated from the well-known equation

$$N = \frac{\lambda W}{hc} \times 10^7 \quad (21)$$

where N is the photon yield per sq. mm. per second,

W is the energy of the light emitted each second by the screen in watts per square millimeter,

λ is the wavelength of the emitted light,

h is Planck's constant, and

c is the speed of light.

Now the measured energy of the light emitted by the screen per square millimeter per second was 5×10^{-3} microwatts. Since the average wavelength of the light produced by the type B-2 screen is 540 millimicrons (see Fig. 2), the number of light photons emitted by the screen per square millimeter per second during the test was therefore 1.5×10^{10} . If we assume that all roentgen-ray photons absorbed by the screen are utilized in the production of light and if we take the previously calculated number of roentgen-ray photons incident on each square millimeter of the screen as 5×10^6 per second, then each roentgen-ray photon produces approxi-

mately 5,000 useful light photons. In view of such a yield, the numbers of light photons emitted per square millimeter of screen surface each second during chest, anteroposterior abdominal and lateral abdominal roentgenoscopy are 1.7×10^9 , 1.3×10^8 , and 1.2×10^7 respectively.

The number of these photons which gain admittance to the observer's eyes is governed by the viewing distance, the size of the observer's pupils, and the light intensity distribution function of the screen. Now most roentgen screens approximate a Lambert type of distribution function and

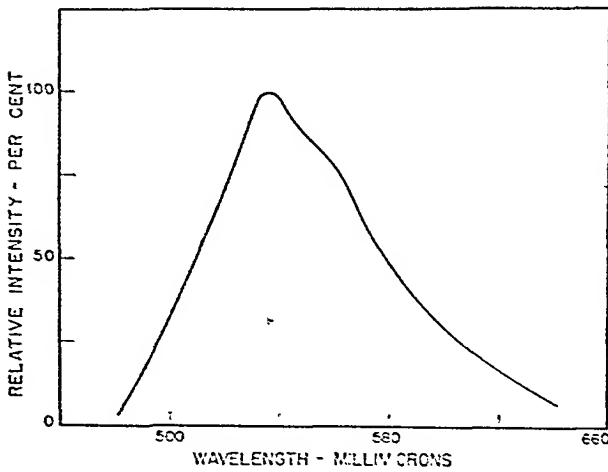


FIG. 2. Spectral emission of the Patterson type B-2 roentgenoscopic screen.

therefore the fraction of the photons that enter the pupil may be shown by simple optical physics to be

$$f = \frac{D^2}{4d^2} \quad (22)$$

where D is the diameter of the pupil and d is the viewing distance.

Under the lighting conditions encountered at roentgenoscopy (i.e., 1.7×10^9 to 1.2×10^7 photons / sec. / sq. mm. of screen surface), Reeves¹⁰ has shown that the diameter of the pupil ranges from 7.0 to 7.6 mm. (see Fig. 3). Since under customary roentgenoscopic practice, a viewing distance of about 200 mm. is employed, f therefore has a value ranging from 2.5×10^{-4} to 3×10^{-4} and the numbers of photons which gain admittance to the retina from each square millimeter of the screen per second are

5×10^5 , 3.5×10^4 and 3.0×10^3 for the three types of roentgenoscopy previously cited.

Of the photons that gain admittance to the eye, only a small portion is effective in stimulating the retina. Rose has estimated that the number ranges from 0.5 per cent at high levels of illumination to 5.0 per cent at low levels of illumination. These values of

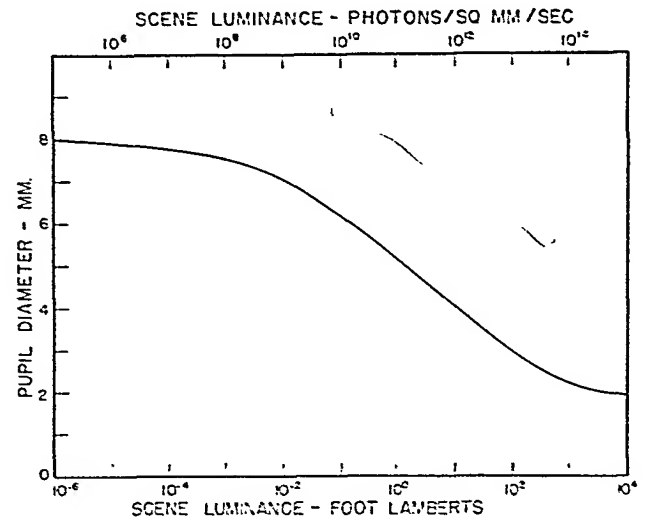


FIG. 3. Relationship between pupil diameter and scene luminance (after Reeves¹⁰).

retinal efficiency were calculated with the aid of equation (19) from data on visual performance, published by Connor and Ganoung,⁵ Cobb and Moss,³ and Blackwell.¹ In these calculations, Rose employed a value of 0.2 second for the storage time of the eye and a value of 5.0 for the threshold contrast to fluctuation ratio. On the basis of considerable evidence cited by Rose, the value for the storage time of the eye is probably valid within reasonable limits through the complete range of scene luminance encountered in roentgenoscopy and in the observation of roentgenographic films. The value for the threshold contrast to fluctuation ratio was determined experimentally only for high levels of illumination by Rose. Although he is uncertain that this value is correct at low levels of scene luminance, we believe it is significant that his calculated value of retinal efficiency at low illumination, determined from a threshold contrast to fluctuation ratio of 5.0, is closely similar to that of Hecht,⁷ obtained

independently by experimental measurements on threshold vision.

Although the available evidence indicates that the efficiency of the retina possibly falls between 0.5 per cent at high levels of illumination and 5.0 per cent at

will approach its maximum value of 5.0 per cent and that for anteroposterior abdominal and chest fluoroscopy, somewhat lower values, possibly 3.0 and 1.5 per cent respectively, will prevail. If such values are applied to the data previously given for the number of photons which gain admittance to the eye, it appears that about 7.5×10^3 , 1.0×10^3 and 1.5×10^2 photons per second reach and stimulate the retina from each square millimeter of screen surface in the three types of roentgenoscopy under consideration. These then, are the values of n_0 for use in equation (19).

The foregoing series of events which occur in the process of roentgenoscopy is illustrated graphically in Figure 4. There it will be seen that the number of available photons gradually diminishes as the fluoroscopic process progresses until a low point is reached at the stage where roentgen-ray photons are absorbed by the fluoroscopic screen. Thereafter there is a steep rise as roentgen-ray photons are converted to light, and then a long descent at the end of the process when photonic energy finally stimulates the photoreceptor mechanism of the retina. It is evident that the point of lowest intensity within the system is at the final stage of the process. Therefore, for simple roentgenoscopy the value of g in equation (19) is unity. From the values of

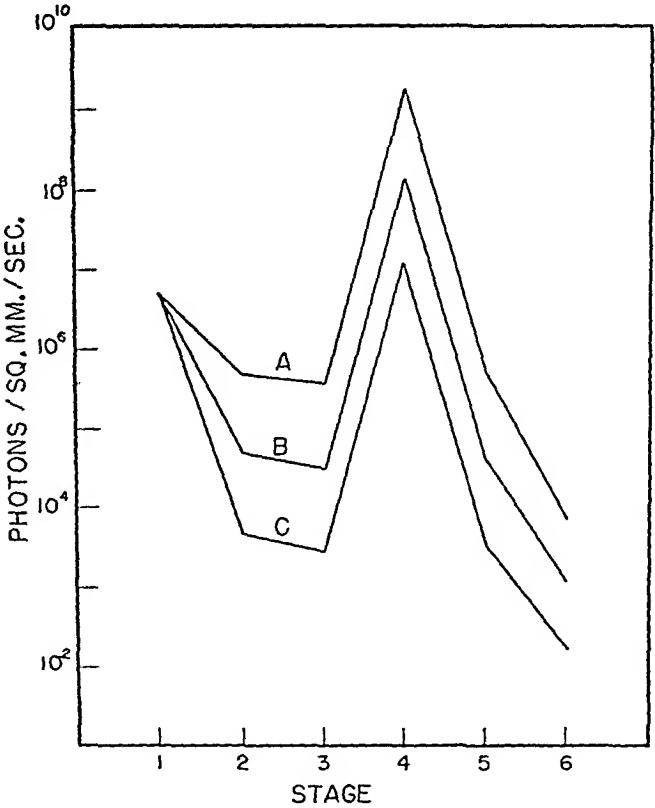


FIG. 4. Graphic representation of the photon densities that exist during the several stages of the roentgenoscopic process. Stage 1: number of roentgen-ray photons projected by roentgen tube toward each square millimeter of screen surface per second; stage 2: number of projected photons remaining after absorption of beam by anatomical tissues; stage 3: number of roentgen-ray photons absorbed by roentgenoscopic screen; stage 4: number of useful light photons produced each second by each square millimeter of screen surface; stage 5: number of light photons which gain admittance to the eye, and stage 6: number of photons admitted to the eye which stimulate the retina. Curve A is for roentgenoscopy of the chest, curve B for anteroposterior roentgenoscopy of the abdomen, and curve C for lateral abdominal roentgenoscopy.

low levels of illumination, this evidence is insufficiently complete to permit the precise evaluation of retinal efficiency at the various levels of scene luminance occurring at roentgenoscopy. It seems reasonable to assume, however, that, for lateral abdominal fluoroscopy where scene luminance is extremely low, the efficiency of the retina

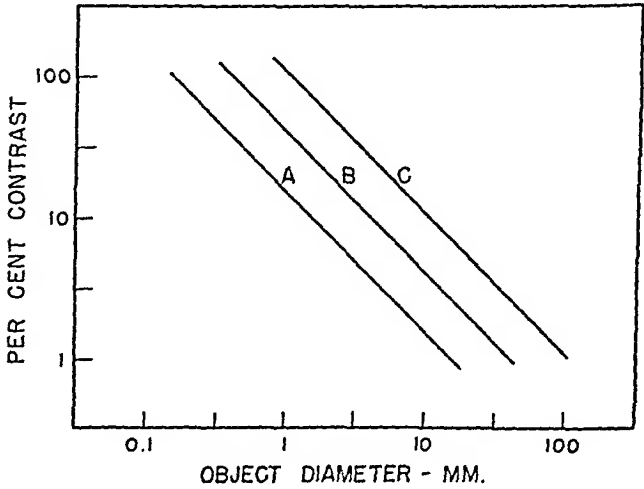


FIG. 5. Theoretical visual performance curves in which percentage threshold contrast is plotted as a function of minimum perceptible object diameter. The designations A, B, and C are for the same conditions given in Figure 4.

n_0 , g , t , and k , calculated or cited in the preceding paragraphs, the limits imposed by fluctuation theory on the size and contrast of objects seen at roentgenoscopy may be easily calculated. Curves derived from

seen under chest roentgenoscopic conditions than at abdominal roentgenoscopy. Also, for lateral abdominal work, the object size must be relatively large before it can be seen. Indeed, objects of 10 per cent

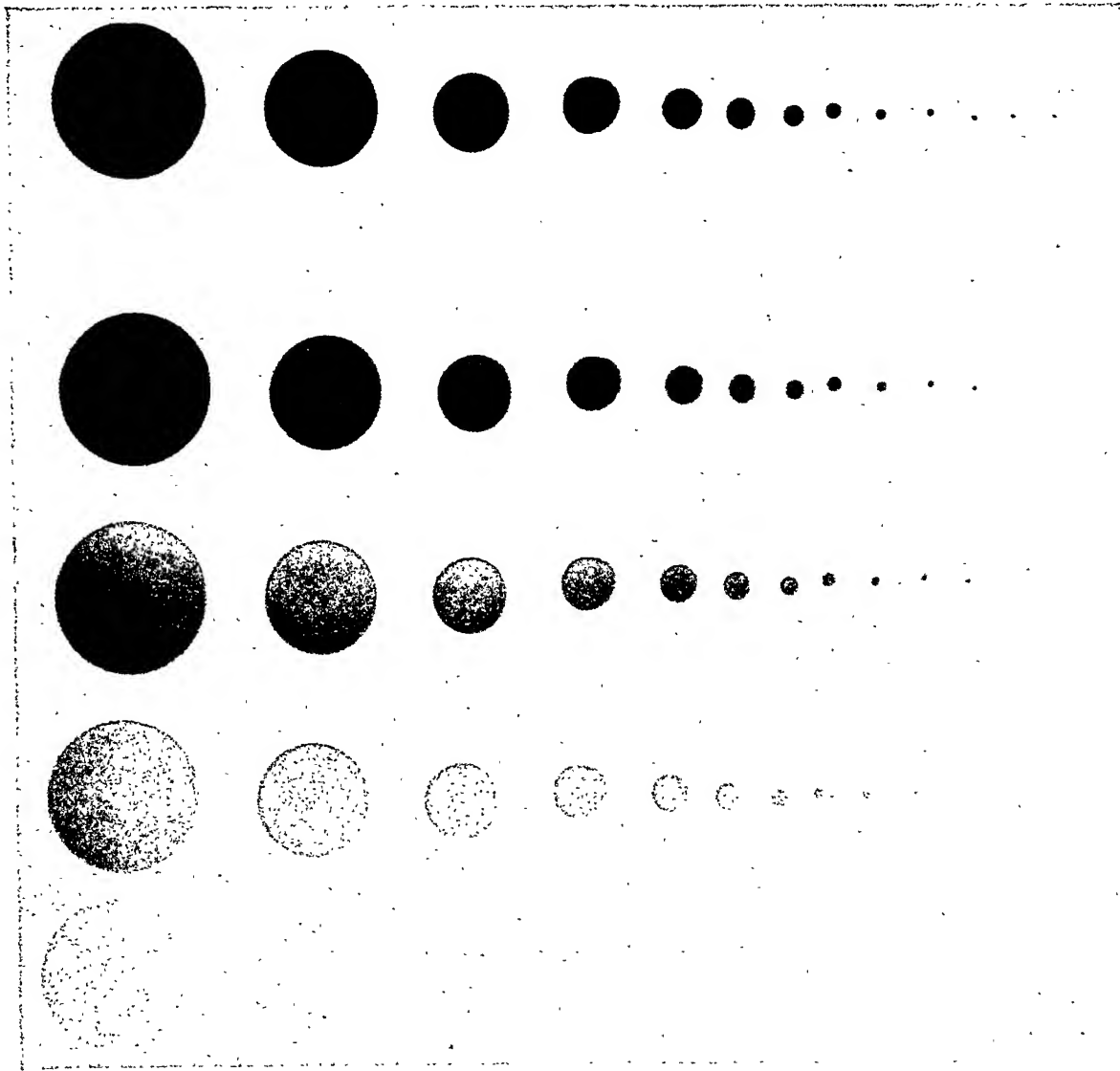


FIG. 6. Portion of the test pattern used in the experimental determination of visual performance at roentgenoscopic levels of scene luminance.

such calculations in which just perceptible object size is plotted as a function of contrast for chest, anteroposterior abdominal and lateral abdominal roentgenoscopy are shown in Figure 5. Objects having a size and contrast that fall above and to the right of each curve should be readily visible to an observer. Objects having a size and contrast that fall below and to the left of each curve should not be seen. As one might expect, considerably smaller objects may be

seen under chest roentgenoscopic conditions than at abdominal roentgenoscopy. Also, for lateral abdominal work, the object size must be relatively large before it can be seen. Indeed, objects of 10 per cent

contrast must be 10 mm. in diameter before they may be detected. At this point, one may reasonably inquire about the correlation that exists between the purely theoretical calculations that have just been made for the visual performance of roentgenoscopy and experimental measurements of this same performance. Obviously, if the correlation is poor, there is little justification in carrying these discussions further in an attempt to

predict the visual responses which may occur at roentgenoscopy when the eye is aided by screen intensification. Reliable data giving the size and contrast of objects that are just perceptible under various roentgenoscopic conditions have not heretofore been published. Accordingly, an experimental investigation by which such data could be collected was established. A lead plate in which were perforated holes varying in size from 1 mm. to 22.4 mm. in

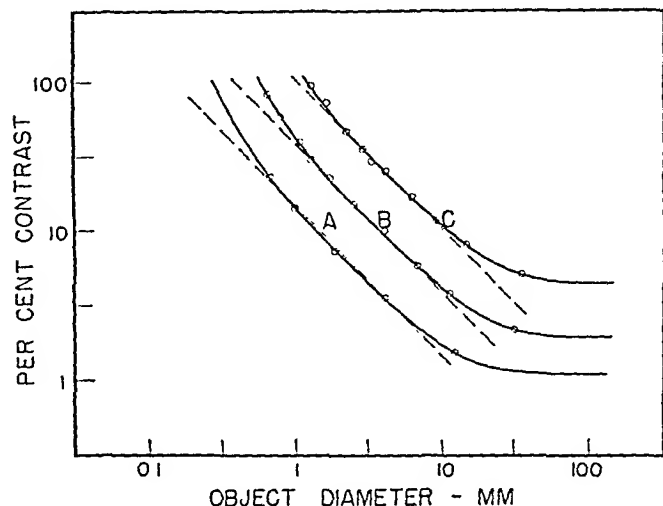


FIG. 7. Experimental visual performance data obtained under roentgenoscopic conditions equivalent to *A*, roentgenoscopy of the chest; *B*, anteroposterior roentgenoscopy of the abdomen and *C*, lateral abdominal roentgenoscopy. Screen: Patterson type B-2; viewing distance: 200 mm.; tube voltage: 70 kvp.; tube current: 5 ma.; tube-screen distance: 27 inches.

diameter was prepared and roentgenographed several times on a film 8 by 10 inches in size. The several exposures were varied through a sufficient range that the images of the holes appearing on the film presented contrasts with their surrounding fields ranging from 2.5 per cent to 94 per cent. The film (Fig. 6) was then mounted on the face of a Patterson type B-2 screen and after the edges of the screen beyond the film were masked off, the screen-film combination was mounted in a typical roentgenoscopic unit. A roentgen beam was then projected on the screen and adjusted to give yields of 1.2×10^9 , 1.3×10^8 , and 1.7×10^7 light photons per second per square millimeter of screen surface. As previously pointed out these yields are

closely equivalent to those occurring at chest, anteroposterior abdominal and lateral abdominal roentgenoscopy. Six observers, free of optical defects, were then taken into the experimental room and allowed to become dark adapted for a period of one hour. Each observer was then placed in turn before the roentgenoscope at a viewing distance of 200 mm., and observations of the smallest perceptible object for each of the several contrast levels were made. Observations were first made at the screen luminance of lowest intensity, then the intermediate intensity, and finally the highest intensity. The averaged data for the six observers are shown graphically in Figure 7, where object size is plotted against object contrast. The solid lines represent the experimental observations while the dotted lines represent the calculated values illustrated in Figure 5.

If the agreement between experimental and calculated data seems striking, it must be remembered that the calculated data were obtained by applying to equation (19) parameter values that were determined under experimental conditions not dissimilar to those existing during our study. Hence the agreement is no more than might have been expected. In addition to this, however, we believe it is quite significant that the experimental curves, over major portions, exhibit the same slope as the calculated curves. This fact seems to justify considerable confidence in the fluctuation theory of vision for there is no other apparent explanation of the phenomenon.

It will be observed that when the size of an object is small or its contrast low, deviations from the calculated curves appear in the experimental data. The deviations from the calculated values for small objects may be explained by the presence of light dispersion within the eye. This dispersion reduces the contrast and border sharpness of the retinal images and accordingly makes the perception of those images abnormally difficult. The effect is logically greatest when object size is small.

At low contrast levels, the deviations from the calculated curves may be traced

to another phenomenon of optical physiology. When an object under observation is small it is appreciated in its entirety by a single fixation of the eye. However, when the object becomes larger, eventually a size is reached beyond which the eye must scan the object with multiple points of fixation if complete comprehension is to be obtained. That is to say, the object eventually becomes greater than the eye's maximum field of appreciation. Now when an object is of such size that it covers more than the maximum field of appreciation, it is reasonable to expect that the eye's contrast discrimination will be no greater than that produced by an object of a size just sufficient to cover this maximum field. Therefore, as one progresses to larger object sizes, the experimental curves of visual performance may be expected to deviate from calculated values based on fluctuation theory. It is evident, therefore, that the deviations from fluctuation theory which occur in the experimental curves of Figure 7 in no way invalidate this theory. Instead, they are manifestations of phenomena which under certain circumstances impose additional limitations on visual performance. Thus there appears to be little doubt that visual performance may be reasonably predicted from fluctuation theory and that we are justified in proceeding now to a discussion of the visual performance that might be obtained with an ideal screen intensifying device.

IV. IDEAL SCREEN INTENSIFICATION SYSTEM

It is clear from fluctuation theory that one's visual performance at roentgenoscopy can be improved only by increasing the number of photons which reach and stimulate the eye each second from the fluorescent screen. Now such an increase could be achieved by raising the voltage and current of the roentgen tube or by decreasing the tube-screen distance of the fluoroscope. These procedures, however, are open to serious criticism since they expose the patient and roentgenologist alike to the hazards of excessive radiation. Another method of obtaining an increased

number of photons for the retina is the application of some sort of screen intensifying device to the roentgenoscopic system.

Although several methods of screen intensification have been proposed in recent years, none has been developed sufficiently far to permit intensive clinical trial. Therefore, it is not possible at this time to evaluate the improvement in visual perception that may be obtained with any of these methods. It is possible, however, from fluctuation theory, to determine the performance characteristics of an ideal screen intensifier. Although such a device is entirely hypothetical, it does represent the ultimate objective toward which all work in the field of screen intensification is being directed and its performance, accordingly, represents the maximum improvement in visual resolution and contrast discrimination that may be expected from screen intensifying instruments. The consideration of such a device will therefore give us at once a clear picture of what eventually may be gained by brightening the roentgenoscopic screen.

An ideal screen intensification system may be defined as one which absorbs completely all of the incident roentgen radiation falling upon it, one which does not introduce into the roentgenoscopic process any significant fluctuation and one in which the gain is controllable through a limitless range of intensification. For purposes of discussion, let us apply such an ideal screen intensifier to a roentgenoscope in which the roentgen tube is operating at 70 kvp. and 5 milliamperes, in which the roentgen beam is filtered by 1 mm. of aluminum and in which the distance between the roentgen tube and the pick-up surface of the screen intensifier is 27 inches. We have seen in preceding sections that, under these conditions, the roentgen tube projects toward each square millimeter of the intensifier's pick-up surface 5×10^6 roentgen-ray photons per second. We have also seen that when a patient is placed in the roentgen beam this number drops to 5×10^5 photons per second for roentgenoscopy of the chest, 5×10^4 photons per second for roentgenos-

copy of the abdomen in the anteroposterior projection and 5×10^3 photons per second for roentgenoscopy of the abdomen in the lateral projection. When these photons fall on the pick-up surface of the intensifying instrument, their energy is utilized in the production of light photons which form the visible image, perceived by the observer.

Now when the gain control of the ideal

absorption which we have assumed for the ideal screen intensifier.

Now if the gain control of the ideal intensifier is slowly advanced so that the amount of intensification provided by the device becomes greater than that shown in Figure 8A, the number of light photons stimulating the observer's retinae will eventually become equal to the number of roentgen-ray photons absorbed by the intensi-

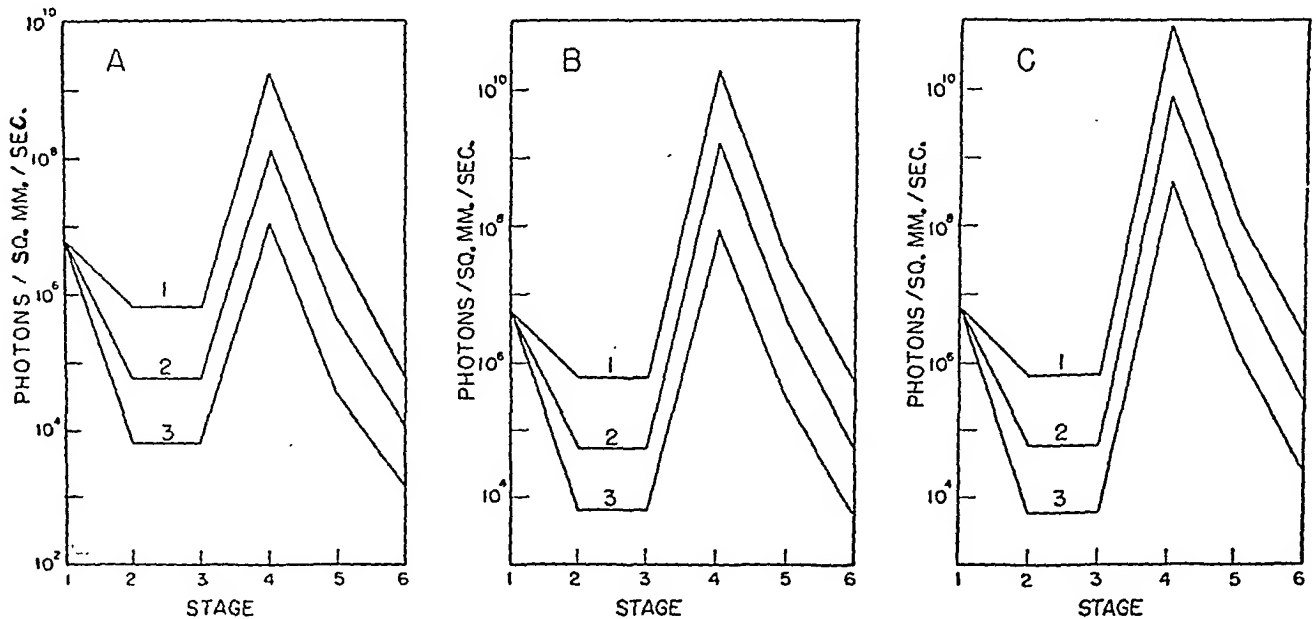


FIG. 8. Graphic representation of the photon densities that might exist during roentgenoscopy when aided by an ideal screen intensifier. *A*: condition where the gain control of the intensifier is retarded to the level at which screen luminance is equivalent to that occurring at simple roentgenoscopy; *B*: condition where the gain control is advanced to the level at which the screen luminance is such that the number of light photons stimulating the retina from each square millimeter of the intensifier's surface is equal to the number of roentgen-ray photons absorbed by the intensifier; *C*: condition where the gain control is advanced beyond *B*. Stages 1 to 6 are of the same significance as those shown in Figure 4. Curve 1: chest roentgenoscopy; curve 2: anteroposterior abdominal roentgenoscopy; curve 3: lateral abdominal roentgenoscopy.

screen intensifier is adjusted to produce a viewing-screen brightness equivalent to that of a Patterson type B-2 screen at simple fluoroscopy and when the viewing distance of the observer is 200 mm., the visual performance of the observer will simply be that given by the previous curves for simple fluoroscopy (see Fig. 7). The series of events which transpire during the use of the ideal intensifier under these circumstances is shown graphically in Figure 8A for each of the three types of fluoroscopy. It will be observed that these events are similar to those occurring in conventional roentgenoscopy and depicted in Figure 4 except for the total roentgen-ray

fier's pick-up surface (Fig. 8B). During this phase of increasing screen luminance, it will be evident from equation (19) that there will occur a simultaneous improvement in the observer's visual performance.

Let us now continue to advance the intensifier's gain control so that the number of photons stimulating the retina rises above the number absorbed by the intensifier's pick-up surface (Fig. 8C). During this phase of increasing screen luminance, no improvement in visual performance can occur for, under these conditions, the stage of the roentgenoscopic process at which light photons stimulate the retina is no longer the stage of lowest intensity. Instead

the stage of roentgen-ray photon absorption by the intensifier's pick-up surface constitutes the stage of lowest intensity and accordingly the value of g , the amplification factor of the roentgenoscopic process between the stage of lowest intensity and the final stage, in equation (19), is no longer unity. Indeed it is quite evident that after the number of photons stimulating the retina exceeds the number of roentgen-ray photons absorbed by the ideal intensifier, a rise in the number of retinal photons is accompanied by a proportionate rise in the amplification factor, g , of the system. Therefore, the effect of increases of n_0 in equation (19) is cancelled by the simultaneously occurring increases in g and no change in visual resolution or contrast discrimination occurs.

This situation has immediate and far-reaching implications for the roentgenologist for it imposes upon even the most perfect screen intensification system well-defined limits to the improvement in visual performance that may be obtained during roentgenoscopy. Contrary to widespread impression, a limitless improvement in visual acuity and contrast discrimination cannot be obtained just by increasing the luminance of the roentgenoscopic screen. Indeed, it will be evident from a perusal of Figures 4 and 8 that no improvement in visual performance will be obtained by screen intensification beyond that produced by an ideal intensifier having a luminance of 30 to 50 times greater than that of a Patterson type B-2 screen. An increase of brightness beyond this range will only decrease the need for dark adaptation; it will not increase the acuity and contrast discrimination of the observer.

The ultimate limits of visual performance that may be obtained by screen intensification may be easily determined for roentgenoscopy of the chest, of the abdomen in the anteroposterior projection and of the abdomen in the lateral projection by applying in equation (19) values of 5×10^5 , 5×10^4 , and 5×10^3 respectively for n_0 , a value of 1.0 for g , and of course values of 5.0 for k and 0.2 for t . Calculations derived

from these values are shown by the curves in Figure 9. In all probability these curves are valid only in their mid-portions since it is likely that the limits of visual performance, when objects of small size or low contrast are viewed, are contracted beyond the limits set by fluctuation theory. At least such was the case for conventional roentgenoscopy (see Fig. 7) and there is no rea-

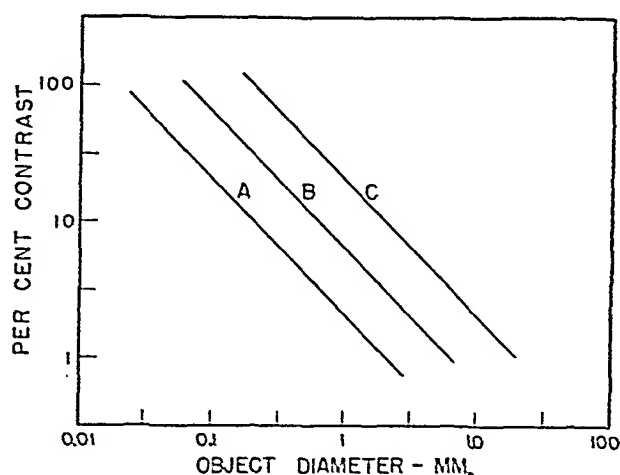


FIG. 9. Theoretical visual performance curves that might be obtained with an ideal screen intensification system. The designations A, B, and C refer to the same conditions as those specified in Figure 4.

son to believe that screen intensification will alter this situation. Therefore one may expect that visual performance will be somewhat poorer than that indicated in Figure 9.

V. VISUAL PERFORMANCE AT ROENTGENOGRAPHY

Let us now consider the visual performance of an individual observing a roentgenographic film. In conventional practice, roentgen-ray photons are projected through the anatomical structure under examination and subsequently are allowed to fall on a pair of calcium tungstate intensifying screens. The fluorescence from these screens exposes the roentgenographic film and produces in it an image which appears after the film is processed. The image is then viewed by placing the film on an illuminator usually having a luminance of about 100 foot-lamberts. Now Coltman *et al.*² have shown that for each roentgen-ray photon absorbed by calcium tungstate screens, approximately 500 useful light

photons are produced. Also, estimates of the quantum efficiency of photographic and roentgenographic emulsions based on experimental evidence yield values in the neighborhood of 1 per cent. Therefore, approximately 5 developable photographic grains are produced in the roentgenographic film for each absorbed roentgen-ray photon, and accordingly the stage at which maxi-

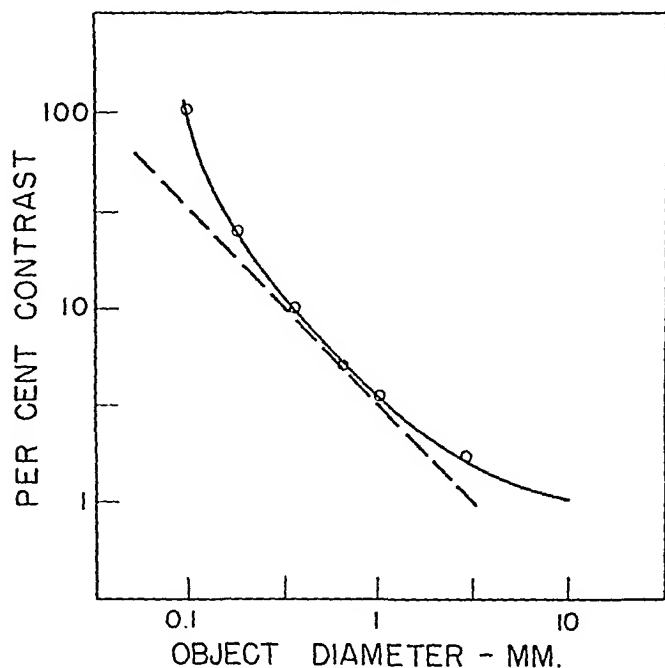


FIG. 10. Visual performance curve of Eastman blue brand film exposed with Patterson par speed intensifying screens.

mum fluctuation is introduced into the process is the stage at which roentgen-ray photons are absorbed by the intensifying screens. Additional fluctuations also occur during the viewing of the film, but by using relatively high levels of illumination (e.g. 100 foot-lamberts) and short viewing distances (e.g. 200 mm.) these fluctuations may be maintained at comparatively insignificant levels.

Recent experimental work⁹ indicates that a typical roentgenographic film-screen combination (Eastman blue brand film and Patterson par speed intensifying screens) when exposed with a 70 kvp. roentgen beam having a half-value layer of 4 mm. of aluminum requires an exposure of 0.001 roentgen to produce a film density of 1.0, the average density of a correctly exposed roentgenogram. From equation (20) such an exposure corresponds to 6×10^4 roentgen-ray photons

per square millimeter. Now the absorption of Patterson par speed screens, with such a beam is approximately 70 per cent. Therefore, 4×10^4 roentgen-ray photons per square millimeter are responsible for the production of the roentgenographic image. When such a value is substituted for the product of $n_0 t/g$ together with the usual value of 5.0 for k in equation (19) the visual performance of a typical roentgenographic film as limited by fluctuation theory may be easily shown to be that illustrated by the dotted curve in Figure 10.

Data on the actual performance of Eastman blue brand film exposed with Patterson par speed screens are not available in the literature for comparison with this theoretical curve. Therefore, such data were obtained experimentally in the laboratory by exposing the film-screen combination with a lead plate having perforations ranging in size from 0.1 mm. to 10 mm. The exposure contrast was varied through a range of 1 per cent to 100 per cent by giving the combination pre-exposures sufficient to yield a total exposure in each case of 0.001 roentgen. The exposures were produced by a 70 kvp. roentgen beam having a half-value layer of 4 mm. of aluminum. The film was then processed and viewed at a distance of 200 mm. on an illuminator having a luminance of 100 foot-lamberts. The results of the test are shown by the solid curve in Figure 10. The close correlation of experiment and theory is indeed striking and gives additional support, if such support is needed, to the importance of fluctuation theory in visual perception. The correlation demonstrated in Figure 10 is particularly significant because it illustrates the correctness of fluctuation theory in a condition where the amount of fluctuation is determined by the number of roentgen-ray photons absorbed by the photosensitive medium. The curves of visual performance for the ideal screen intensifier in Figure 9 were based on a similar condition, and although an ideal screen intensifier is not available for test, the agreement between theory and experiment in Figure 10 indicates that the curves are probably correct.

As was the case in roentgenoscopic vision, there is some deviation between the experimental and predicted curves for objects of small size and low contrast in roentgenography. Such deviations, however, may be reasonably explained on the same basis as that given previously in the section on simple roentgenoscopy and certainly do not in any way invalidate fluctuation theory as a limiting factor in roentgenographic perception.

The experimental curve shown in Figure 10 is applicable with very minor modifications to roentgenography of any anatomical structure since approximately the same number of absorbed roentgens are needed to produce a film of an acceptable density throughout the range of anatomical thickness encountered in medical roentgenography. It will be observed that the roentgenographic film has the great advantage over roentgenoscopy in that as the brightness of the intensifying screens diminishes with increasing anatomical thickness, the exposure time, or more precisely the storage time of the film, increases reciprocally to maintain the observer's visual performance at a high level. In roentgenoscopy, the storage time of the recording medium is simply that of the observer's eyes. This time, as we have seen, is independent of screen illumination and accordingly visual performance deteriorates when heavy structures are roentgenoscoped. In Figure 11, the visual performance curves of simple roentgenoscopy, of roentgenoscopy aided by an ideal screen intensifier and of roentgenography are plotted for three different conditions. Figure 11*A* applies to the examination of the chest, Figure 11*B* to the examination of the abdomen in the anteroposterior projection, and Figure 11*C* to the examination of the abdomen in the lateral projection. It will be seen that only in the examination of the chest does the performance of the ideal screen intensifier approach that of roentgenographic film. In the examination of the abdomen its performance begins to fall short of that of film and this is particularly so when the structures under examination are heavy. How-

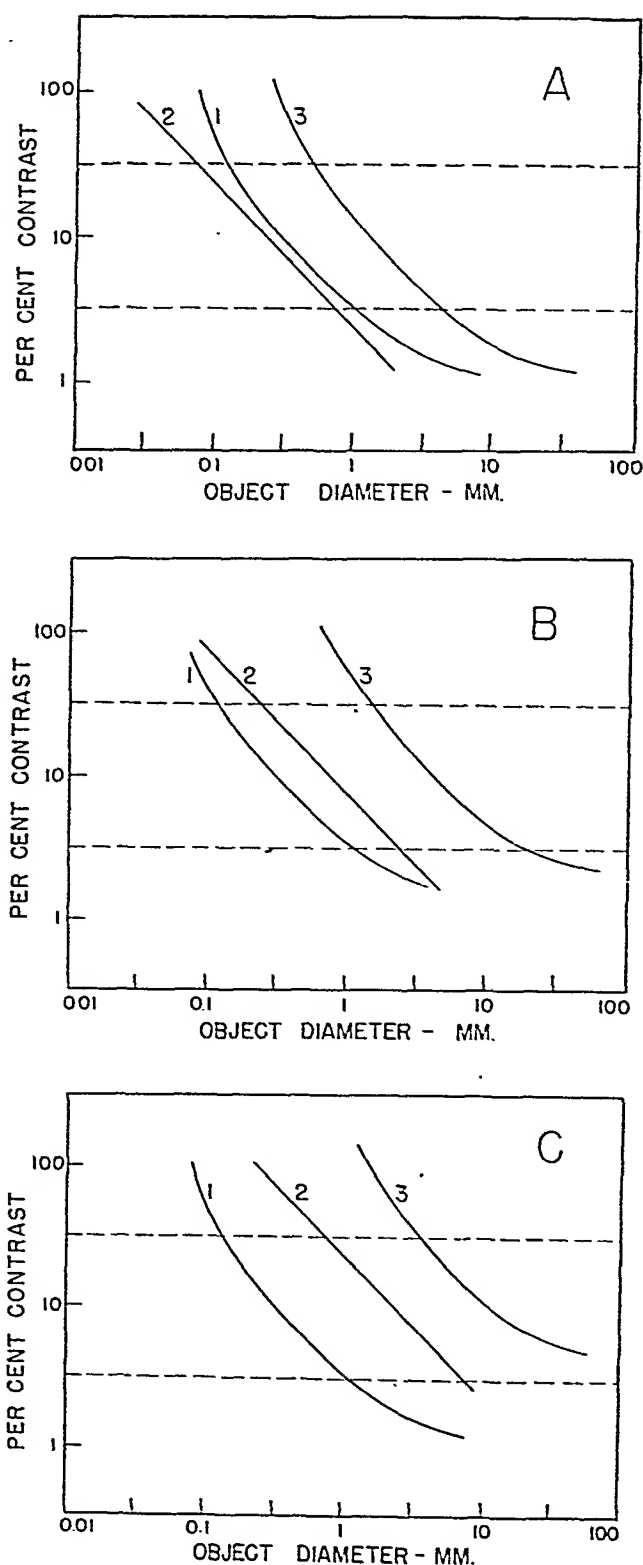


FIG. 11. Visual performance data showing the comparative merits of (1) roentgenography; (2) an ideal screen intensifier; and (3) simple roentgenoscopy. *A* refers to conditions equivalent to those occurring during the examination of the chest; *B* to conditions equivalent to those occurring during the examination of the abdomen in the anteroposterior projection; and *C* to conditions equivalent to those occurring during the examination of the abdomen in the lateral projection.

ever, even though these benefits to be derived from screen intensifications are more limited than many had anticipated, they are nevertheless sufficiently impressive to warrant enthusiastic anticipation of practical intensifying devices. Of course, it is unlikely that such instruments when they become available will approach the ideal curves shown in Figure 11. For several years there doubtless will be an evolutionary period during which the available screen intensifiers will fall short of the ideal intensifier. However, there appears to be no reason why screen intensifying devices providing very real benefits should not eventually be obtainable.

This, then, is the outlook for screen intensification. Perhaps it is not as impressive as many had hoped for. It must be emphasized again, however, that the fundamental limitation on visual performance during screen intensification is the number of roentgen-ray photons absorbed by the intensifying device and we are indeed fortunate that reasonably large improvements are attainable within the limits of roentgen exposure imposed by sound clinical practice. It should also be pointed out that although the maximum improvement in visual acuity and contrast discrimination that may be obtained with an ideal screen intensifier will occur at gains of 30 to 50 times over the Patterson type B-2 screen, much higher gains will probably be desirable in practical instruments for several reasons. Gains of 500 to 1,000 times above the B-2 screen are needed if dark adaptation is to be avoided. Such gains also may be necessary if the image quality of the instrument is to approach that of the ideal screen intensifier. Hence, the need of energetic investigation which will lead to the development of high gain screen intensifiers cannot be questioned. It appears, however, that the benefits derived from such intensification will be principally concerned with the elimination of dark adaptation rather than with enormous gains in the observer's visual acuity.

VI. SUMMARY

The benefits to be derived from screen

intensification systems are predicted by calculating the visual performance of an ideal screen intensifier from statistical fluctuation theory. It is shown that for roentgenoscopy of the chest and of other structures of comparable radiolucency one may ultimately expect the visual performance of screen intensifiers to approach that of roentgenographic film. Roentgenoscopy of the abdomen and similar structures, however, will not likely be as satisfactory due to limitations imposed by the amount of roentgen exposure which may be safely tolerated by the patient and roentgenologist.*

Johns Hopkins Hospital
Baltimore 5, Maryland

REFERENCES

1. BLACKWELL, H. R. Contrast thresholds of the human eye. *J. Optic. Soc. America*, 1946, 36, 624-643.
2. CHAMBERLAIN, W. E. Fluoroscopes and fluoroscopy, *Radiology*, 1942, 38, 383-413.
3. COBB, P. W. and MOSS, F. K. The four variables of visual threshold. *J. Franklin Inst.*, 1928, 205, 831.
4. COLTMAN, J. W., EBBIGHAUSEN, E. G., and ALTAR, W. Physical properties of calcium tungstate x-ray screens. *J. App. Phys.*, 1947, 18, 530.
5. CONNOR, J. P., and GANOUNG, R. E. Experimental determination of visual thresholds at low values of illumination. *J. Optic. Soc. America*, 1935, 25, 287-294.
6. HECHT, S. Relation between visual acuity and illumination. *J. Gen. Physiol.*, 1928, 11, 255-281.
7. HECHT, S. Quantum relations of vision. *J. Optic. Soc. America*, 1942, 32, 42-49.
8. MORGAN, R. H. Analysis of physical factors controlling the diagnostic quality of roentgen images. Part III. Contrast and the intensity distribution function of a roentgen image. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 55, 67-89.
9. MORGAN, R. H., and VAN ALLEN, W. W. The sensitometry of x-ray films and screens. *Radiology*. To be published.
10. REEVES, P. Response of the average pupil to various intensities of light. *J. Optic. Soc. America*, 1920, 4, 35.
11. ROSE, A. Sensitivity performance of the human eye on an absolute scale. *J. Optic. Soc. America*, 1948, 38, 196.

* For discussion, see page 637.

CLINICAL POTENTIALITIES OF SCREEN INTENSIFYING SYSTEMS*†

By RUSSELL H. MORGAN and JOHN F. ROACH

BALTIMORE, MARYLAND

IT IS perhaps idle and even foolhardy to discuss the clinical potentialities of screen intensification systems when a practical device providing an appreciable increase in screen brightness is not yet available. However, the information given in earlier papers this afternoon by Sturm and Morgan and by Coltman** makes it possible to anticipate, in part at least, the course which roentgenology may take when bright fluoroscopic screens can be obtained.

At the outset, it is clear that the benefits to be derived from screen intensification are sufficiently great to insure a much wider use of roentgenoscopy than at present. Not only may the roentgenologist be able to see more clearly than in the past, but with the gains in screen brightness of five hundred times expected with the Coltman image tube, screen luminance will be sufficiently great to be well within the range of cone vision even when the thickest anatomical structure is examined. Thus long periods of dark adaptation before roentgenoscopy will no longer be necessary and the fluoroscope will attain a degree of convenience heretofore unknown.

The wider use of roentgenoscopy will doubtless have a number of significant ramifications. First, the method by which roentgenology is practiced will undergo important and beneficial changes. Henceforth the roentgenologist will be brought into closer and closer contact with his patients under conditions more conducive to a satisfactory patient-physician relationship. The patient's apprehensiveness occasioned by the totally darkened roentgenoscopic room will be gone; the technical

nature of the examination will be subordinated, and the professional role of the roentgenologist will become increasingly apparent to the patient. These are certainly changes that will be welcomed by everyone, for their medico-social implications are obvious.

The wider use of roentgenoscopy among roentgenologists may be expected to extend to those physicians who are not fully qualified in the use of roentgen methods. Although this is an undesirable situation, it is one that presents one advantage. The use of roentgenologic methods in the diagnosis of disease will be increasingly emphasized and the need of competent roentgenologic assistance will ultimately be apparent to all conscientious physicians. It does not appear that the roentgenologist has anything to fear from the increased ease with which his tools may be used following the introduction of screen intensification methods. On the contrary, this evolution may be expected to lead only to a more prominent place for the roentgenologist in the practice of medicine.

The increased application of roentgenoscopy will not be without its technical dangers, for the roentgenologist will be exposed to quantities of radiation considerably in excess of those currently encountered unless more rigid protective measures than those now followed are employed. Fortunately, the greater visibility of the screen will tend to reduce the exposure of patient and physician. Furthermore, as inferred by Sturm and Morgan, the roentgen beam may be reduced in intensity, if desired, by a factor of 30 to 50 times when an ideal screen intensifier is used without reducing the clarity of per-

** See Coltman, J. W. Fluoroscopic image brightening by electronic means. *Radiology*, 1948, 51, 359-367.

* From the Department of Radiology, The Johns Hopkins Hospital and University. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

† The work presented in this paper was supported by a grant from the National Cancer Institute, the National Institute of Health, United States Public Health Service.

ception below that now obtainable at roentgenoscopy. However, if the benefits of increased perception provided by screen intensification are to be achieved, it is fairly evident that such reductions in beam intensity should not as a rule be made, but instead efforts should be directed toward improvements in the protection afforded the roentgenologist.

The clinical benefits of screen intensification are of course enormous and appear to be greatest in the examinations of the chest and of the extremities where the visibility of the screen may be expected to approach that of roentgenographic film. However, unlike film which restricts the roentgenologist to, at most, a few glimpses of the structure of interest, the intensified fluoroscopic screen will provide an almost limitless scrutiny of the patient. The detection of pathological anatomy will thereby be obviously facilitated.

Of even greater importance than the ease with which pathological changes may be elicited, will be the facility with which normal and abnormal physiological states may be studied. For example, the physiological phases of orthopedics will be amenable to a thoroughness of investigation heretofore unattainable by other methods. Certainly the field of roentgen physiology will offer an immediate challenge to countless roentgenologists in the study of many anatomical systems just as soon as practical intensifying instruments are available.

Screen intensification methods will probably accentuate the place of photofluorography as a diagnostic aid. It is anticipated that physicians will always wish to have pertinent film evidence of abnormal changes within a patient for comparison at subsequent examinations. In many respects, photofluorography offers an ideal solution to this problem. With the increased screen brightness provided by intensification systems, photofluorographic apparatus using lenses of smaller aberration and films of finer grain may be expected to produce photofluorograms having a clarity equivalent to that of standard roentgenograms. If

such is the case, a patient's permanent film record may be obtained more quickly and easily than is possible with present-day roentgenographic equipment. The advantages of the small film in its filing will also be very worth while.

The barriers to practical roentgen cinematography will largely be removed by screen intensification systems, for the now excessive exposures of patient and equipment should then be no longer necessary. The study of cardiac physiology by means of opaque material, and the study of the dynamics of the musculo-osseous system may be expected to be greatly benefited by these developments.

It is of course impossible to anticipate at this time more than a few of the results that will occur when instruments for intensifying the fluoroscopic screen become available. One thing is sure, however, and that is that roentgenology will assume a position of importance in the practice of medicine unequalled heretofore. A few problems, particularly in the field of protective technology, will be introduced by this new development. However, the experimental, clinical, and social benefits are so enormous that they far outweigh these minor disadvantages. Only after the next few years will we begin to appreciate the exact significance of this new adjunct to roentgen diagnosis. From the foregoing, it must not be inferred that screen intensification systems are likely to revolutionize the practice of roentgenology. Such a development is far from probable. Instead it appears more reasonable to expect that the availability of screen intensifiers will begin a systematic evolution of roentgenologic practice which will extend over a period of many years. At first, the new screen intensifiers may fall far short of the ideal as far as clarity of reproduction is concerned. The first instruments also may not be as convenient in use as desired. For example, the Coltman image tube will require the roentgenologist to observe the brightened fluoroscopic screen through a telescopic eyepiece; such a viewing method will ob-

viously be clumsy and unsatisfactory to most roentgenologists. However, as time progresses, new developments will bring practical screen intensification systems even closer to the ideal until ultimately intensifying devices, simple in use, clear in performance, and, it is hoped, inexpensive in price will be generally available to the profession.

Johns Hopkins Hospital
Baltimore 5, Md.

DISCUSSION OF SYMPOSIUM ON THE INTENSIFICATION OF THE ROENTGENOSCOPIC SCREEN*

DR. PAUL C. HODGES, Chicago, Ill. It was fitting and right that Dr. Chamberlain's paper† should have been the first one on this program today because in this as in so many other phases of roentgenology, Dr. Chamberlain's ideas and work have started a whole train of events. Dr. Chamberlain was a prime mover in pelvimetry and cardiology and now has stimulated our interest in amplification of fluoroscopic images.

It was Chamberlain's ideas that led Dr. Morgan to be interested in image amplification when he was with us at the University of Chicago and, as you have heard here today, that interest has been continued and intensified now that he has his own department at Johns Hopkins University.

I shall make my own discussion of these papers as brief as possible so that time may be made available for Professor Moon. Moon had been invited to present a paper in this symposium but at the time of the invitation it seemed unlikely that his work would be far enough advanced to warrant a report. He requested, therefore, that he be allowed merely to discuss these other papers. As a matter of fact, his work has progressed more rapidly than we anticipated and it has seemed to us that the purpose behind this symposium will best be served by having him devote his time to telling you of the progress that he has made in the particular form of amplification that he pub-

lished in the June, 1948 number of this JOURNAL.

As to the paper by Drs. Sturm and Morgan, I know from long experience that a great many of Dr. Morgan's hunches do turn out to be correct but he would be the first to tell you that sometimes they are wrong. I hope that this time he and Dr. Sturm are a little too conservative and picture the scene a little darker than it really is.

In regard to Dr. Coltman's paper, the simplicity of his design is a desirable feature and one that justifies the hope of early and relatively inexpensive adaptation to clinical use but, as he points out, the amount of amplification presently available is not very great. I am sure he will agree that the search must go on until we have attained a maximum of brilliance and resolving power.

Perhaps the optimum system will prove to be a modification of the tube Dr. Coltman is using today or possibly it will be something that today is totally unthought of. If the best image amplification system that can be conceived by man proves to be, in its experimental phase, as large as a railroad car, obviously it will have no clinical use in that stage of development. Almost surely, however, if such a system proves to be desirable in all respects other than size, engineers will find some means to refine it and reduce its bulk until it can be used clinically.

As to the smallness of the size of the fluoroscopic screen, I agree completely with Dr. Coltman that this is not a defect. For many years we have done all of our gastric fluoroscopy with a 4½ by 7 inch fluoroscopic screen and find that size adequate.

DR. ROBERT J. MOON, Chicago, Ill. When Dr. Paul Hodges presented the problem of the amplification of the fluoroscopic image to me about a year ago in a casual conversation, it was just one of those interesting discussions at the time. However, it was well to have this information in mind; for subsequent developments that occurred last February in some work which we were doing in our Institute of Radiobiology and Biophysics appeared to be immediately applicable to the amplification of the roentgenoscopic image. A scheme for the solution of Dr. Hodges' problem was drawn up and discussed with him, the result of which was that he urged this line of approach be investigated as to its possibilities. Preliminary measurements showed the feasibility of the idea. This particular method

* This work has been supported in part by grants from the Wallace O. and Clara A. Abbott Fund of the University of Chicago, the Office of Naval Research, the United States Public Health Service, and the Industrial Sponsors of the Institute.

† Dr. Chamberlain's paper is not available for publication at this time.

was described in a communication which appeared in the June, 1948, issue of the *AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY*. The general scheme of the method is shown in Figure 1 of that paper.

About three months ago, the above paper was discussed with Dr. Szegho, Dr. Polanyi and Dr. Marcy of the Rauland Corporation, and these gentlemen were all very much interested in the general nature of the problem and specifically in the adaptation of one of their projection kinescopes as a scanning roentgen tube for the amplification of the fluoroscopic image. Two such scanning roentgen tubes are now in operating condition. We took our first photograph with such a tube last night, although we had been observing some images with the tube in the past few weeks.

The spot where the cathode particle strikes the target in the roentgen tube moves back and forth across the target and after each transit it takes another path across which is below the preceding path. This is continued until the bottom edge of the target is reached at which time the spot returns to the upper edge of the target and repeats its trip across the target as before. The same procedure is repeated many times a second. This of course is just the way the spot scans the face of a picture tube in a television receiver. The roentgen rays which are generated at the spot where the cathode particles strike the anode are permitted to escape only through a tiny pinhole which is essentially part of the wall of a lead box which encloses this scanning roentgen tube. Thus a tiny search light of roentgen rays is generated which is scanning back and forth with its virtual origin at the pinhole. Thus, after a patient is placed in this roentgen-ray field and the roentgen rays are allowed to fall on a fluorescent screen, which is placed opposite the patient from the pinhole, a roentgenoscopic image would be seen just like that with which you are familiar. There is one essential difference, however; if the screen were observed for a very short instant, say a microsecond, and if a fast fluorescent screen were employed, then only a spot would be seen which would correspond to the position of the roentgen rays at that instant. The fluorescent light pulses from each particular spot are picked up by the photocell and the photocurrent amplified so that it can modulate the intensity of the cathode-ray stream of a kinescope in order that the picture may be reconstructed on a picture

tube just as it is done in television. In the particular experiments which are referred to above, a photograph of a roentgen-ray shadow of an image of a small gear was taken with a 525 line picture (transits of the roentgen-ray beam per frame) with thirty frames per second. The photograph is not of the direct fluorescent screen but of the screen of the kinescope.

Many problems were encountered in the development of this system and the progress has been good towards their solution. One problem was that of finding suitable fluorescent screens which had an extremely short-time fluorescence. By short, I mean something less than a microsecond. It seemed that some of the screens which we had used in the laboratory would be very suitable and then, however, it turned out that most of these had a persistence in some cases as great as 60 microseconds and were not useful. A screen which Mr. Patterson and Mr. Reuter had sent to Dr. Hodges proved to be satisfactory. It is a screen of lead barium sulfate which has an extremely short persistence, and when used at ordinary room temperatures the persistence is imperceptible, though when cooled with liquid nitrogen, the persistence is of the order of 60 microseconds. However (since it is undesirable that it should be necessary to provide for the refrigeration of a fluorescent screen as was thought might be the case from some earlier experiments), this particular screen is most suitable because of the above two reasons for this particular application.

As mentioned above, the fluorescent spot of roentgen rays strikes the screen after passing through the object and a fraction of the fluorescent pulse of near visible light which is generated strikes the photocell. The pulse of photocell current is then amplified by means of a wide band amplifier. Thus amplification both as to picture size and intensity is accomplished electronically and the final image appears on the kinescope. Of course, more than one kinescope can be used for observation by several observers as well as one being reserved for the purpose of being photographed from time to time.

The picture to which I referred above required only about a tenth of a milliroentgen. The photograph is of the kinescope, and the exposure time is in the order of a second. The image seemed to have sufficient quality for television broadcast. Before I show a slide of this photograph I should like to use a slide which

pictures the first model of the scanning roentgen tube.

The first slide is a picture of one of an actual scanning roentgen tube (Fig. 1). On the left side of the tube is seen a small narrow neck which contains the electron gun. The electrons which are emitted from the gun are then accelerated by the electric field which is created by the potential difference between the gun and target

the electrons strike the foil, they then have to pass through the foil in order to reach the window. This particular angle of the roentgen rays with respect to the electron beam is very near the minimum of roentgen-ray intensity and in addition there is the further factor of attenuation of the roentgen radiation by the tantalum foil.

A small lead diaphragm which has an aper-

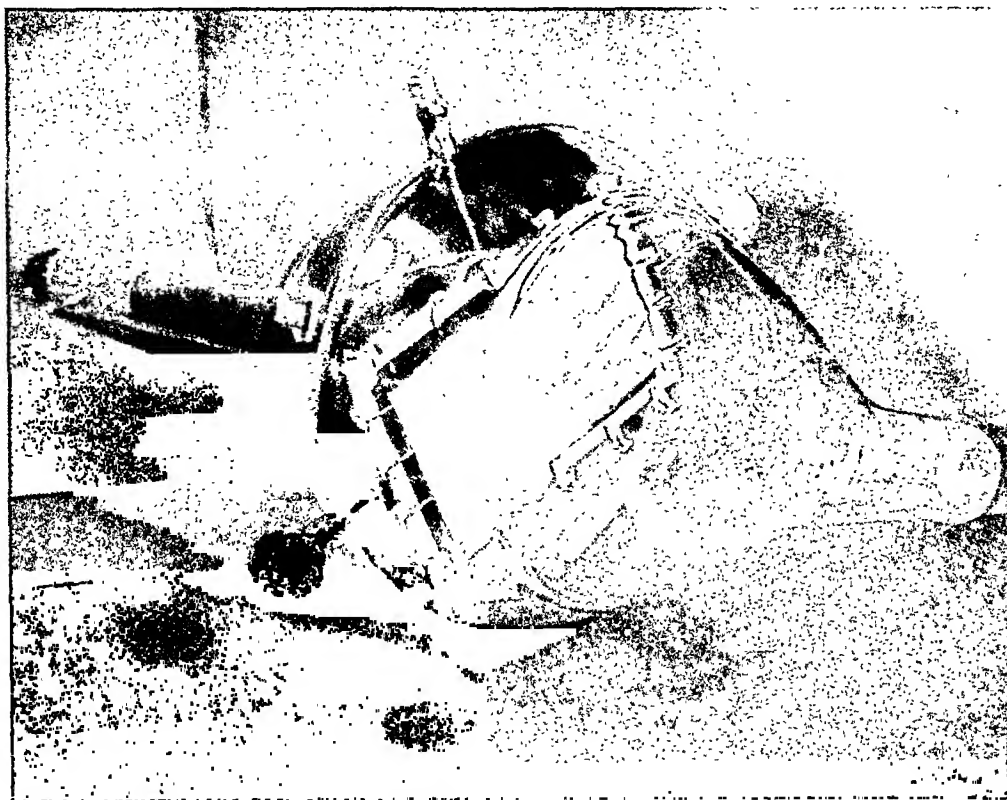


FIG. 1

of some 60,000 volts in this particular tube. The anode or target of this tube consists of a tantalum foil which is one-thousandth of an inch thick and approximately 4 by 7 inches. The foil is stretched by springs in order to keep it somewhat flat since it is operated at an incandescent temperature. This particular tube, as stated earlier, is an adaptation of a projection television kinescope and was made for us by one of the local television tube manufacturers, namely the Rauland Corporation. Essentially the fluorescent screen was cut off and the tantalum target put in its place. The tube was then extended as seen to the right of the picture, and finally terminated in a thin bubble window. The target appears to be somewhat distorted in the slide because of the wrinkles in the glass envelope. Since the roentgen rays are generated where

ture of 0.45 mm. in diameter is placed in position to the right of the bubble window which is approximately 30 centimeters from the tantalum target. As stated earlier, this aperture is really part of the lead box which completely surrounds the scanning roentgen tube. To the right of this aperture, of course, objects are placed which are to be viewed roentgenoscopically. To the right of the object is placed a fast fluorescent screen. This detects the instantaneous number of roentgen-ray quanta which are able to pass through the patient in this narrow beam which has approximately a square millimeter area at the fluorescent screen and a time duration somewhat less than a microsecond. The photomultiplier tube responds to these fluorescent bursts of light and the signal is amplified by a wide band amplifier and the image recon-

structed on the fluorescent screen of a regular television picture tube.

The second slide is a roentgen-ray shadow image of a gear which was taken by means of this device (Fig. 2). This of course is a rather crude picture, first because it is a positive print of the actual photographic negative, and second, it is greatly magnified in size. However, since it is one of the first photographs of its kind it is indeed very gratifying to me person-

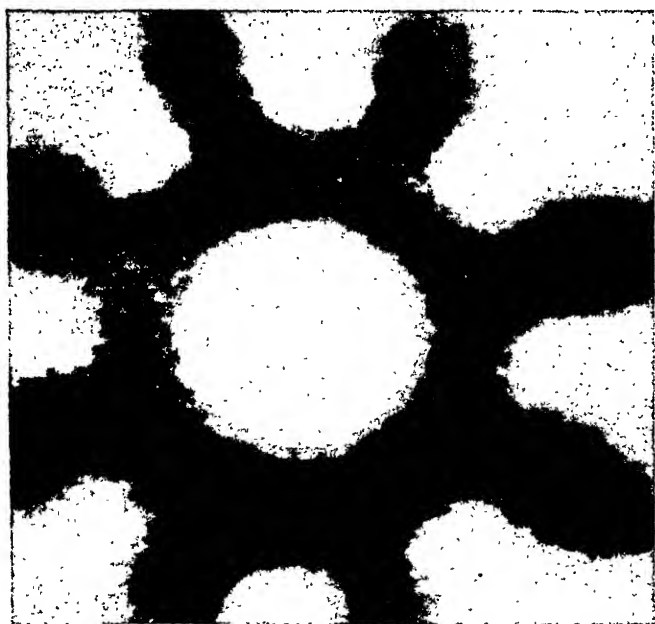


FIG. 2

ally that it is as good as it is. The size of the gear from tooth to tooth through the center is only 16 millimeters. There are some enlargements of the negatives here, which some of you might perhaps like to see after the meeting, in which the over-all magnification is fourteen times. The quantum nature of the roentgen rays is in evidence where the roentgen-ray attenuation is greatest such as in the shadows of the thick portions of the gear, where the picture appears to be constructed of tiny round spots instead of being uniform.

Since the quanta are at various energies from 60 kilovolts to approximately one-fifth of that, the intensity of each individual fluorescent burst will vary approximately five to one with their most probable intensity corresponding, of course, to about one-half of the maximum electron energy, i.e. one-half of 60,000 electron volts in this case. This produces a snowstorm effect and would be visible on the regular fluorescent screen if it were not for the low light intensity. This effect can be nearly elim-

inated by means of a stripper amplifier which causes all quanta regardless of their energy (as long as they are above some set minimum value) to produce the same effect on the fluorescent screen of the picture tube. In other words, this stripper amplifier admits photocurrent pulses which are above a certain minimum value and clips all those photocurrent pulses which are above a certain maximum value. This maximum value is near that of the minimum value. Though the photocurrent pulses may vary five to one, this amplifier makes them appear identical or nearly so.

A roentgenoscopic shadow picture, which is constructed from the number of the roentgen-ray quanta which pass through the object at any one infinitesimal area, should be just as useful in constructing an image, if not more so, than the amount of roentgen-ray energy per infinitesimal area as is ordinarily used. The stripper amplifier followed by a sufficiently wide band amplifier has shown considerable improvement in the picture and this approach has promise of greater improvement in the future. Some dots seen near the edge of the thick portion of the gear, which is in a region of nearly 100 per cent contrast with the surrounding region, are due to some extent to scattered roentgen rays and to a very small extent to persistence of fluorescence or delayed emission of fluorescent light pulses from the thick crystalline fluorescent screen.

The next slide shows another type of high energy kinescope, the design of which might perhaps be adopted to this problem (not illustrated here). It is a type of tube made by the Rauland Corporation and, as you see, looks very much like a pipe. The stem of the pipe contains the electron gun and the bowl of the pipe would contain a water-cooled anode or target for the roentgen tube. The roentgen rays would come from the surface of the tube and could be selected at an angle with respect to the primary electron beam which would yield a maximum intensity of the roentgen rays. The pinhole could be placed somewhat closer to the target. This particular design is an attempt to increase the number of roentgen-ray quanta which are available per picture element in order that the definition of the picture on the kinescope will not be limited because of statistical fluctuation resulting from too small a number of quanta per picture element.

As indicated previously, a rather small

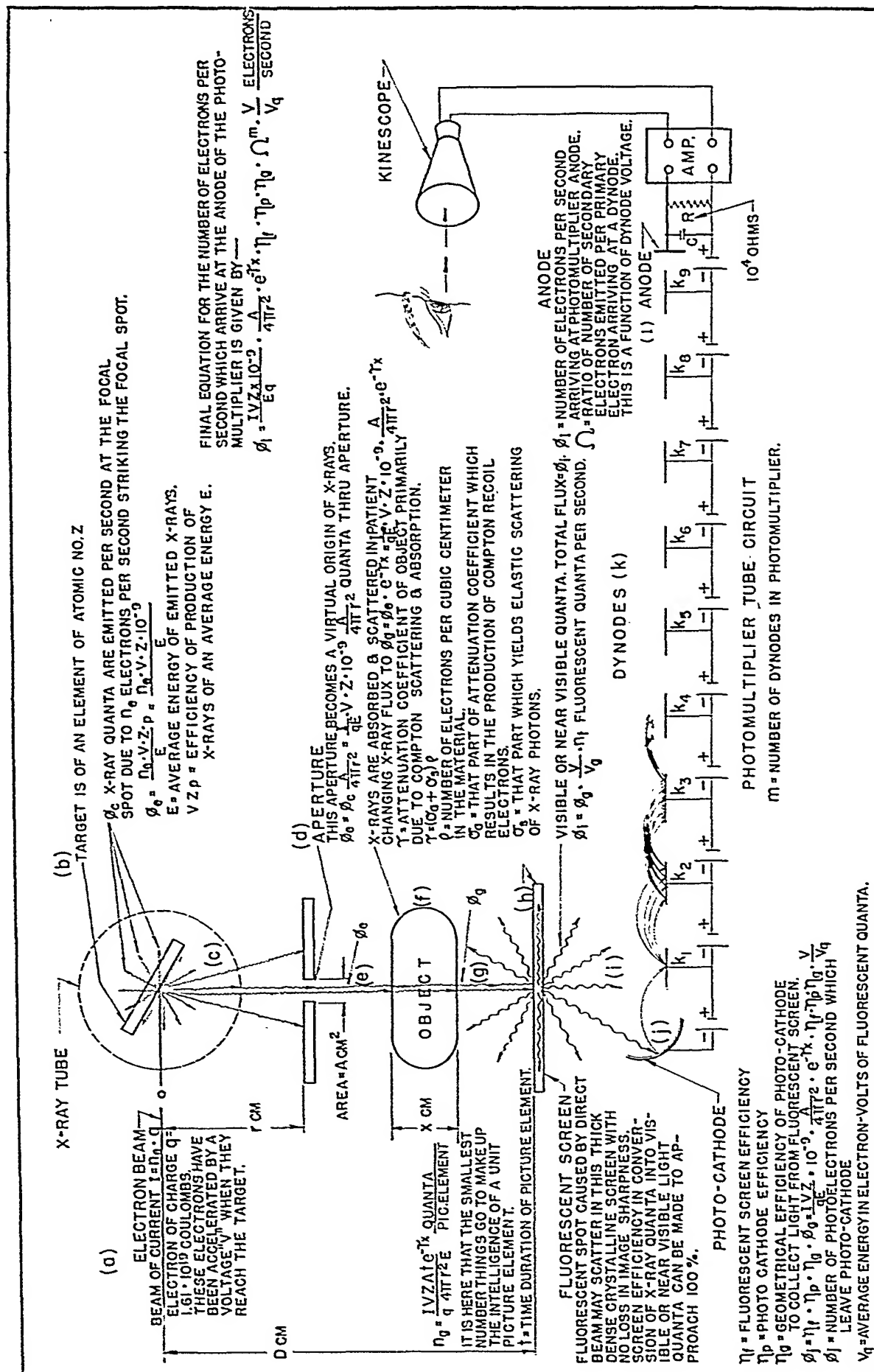


Fig. 3

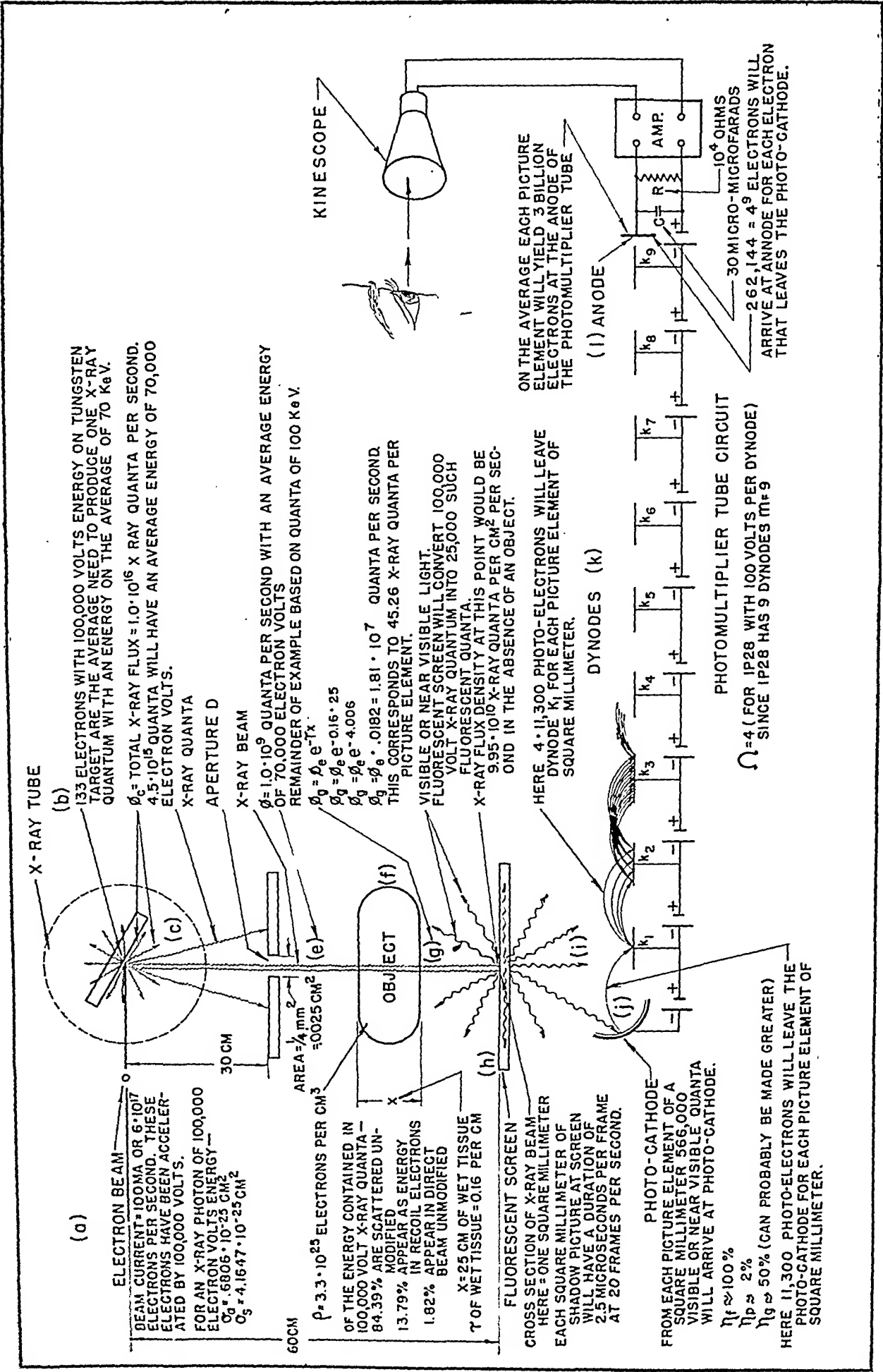


Fig. 4

amount of roentgen rays were used in taking a picture of the gear and were of the order of one-tenth of a milliroentgen. It was obtained with 5 milliamperes of tube current and a tube voltage of 60 kilovolts plus the attenuation due to the transit of the roentgen rays through one mil of tantalum foil and a very poor angle of the roentgen rays in respect to the electron beam which had to be used in this particular model. These last two factors result in an attenuation of possibly six to one. It is planned to use a tube voltage of 125 kilovolts which should increase the yield of roentgen rays by a factor of four over that of the present tube. It is also planned to use a beam current of the order of 100 milliamperes. This would further increase the roentgen-ray yield by a factor of twenty. However, it is interesting to note that the amount of useful roentgen rays generated by such a tube and associated pinhole would still be less than the amount of useful roentgen rays generated per second by the present day tube which is used for roentgenoscopic examinations. It might also be added that if a tilted target type of scanning roentgen tube is used, a line focus principle can be employed since the point of generation of roentgen rays on the target will be viewed at a small angle with respect to the surface of the target.

I might say, as a physicist, I am indeed somewhat optimistic about the future development of a sufficiently potent scanning roentgen tube which will supply sufficient number of quanta in a narrow beam, and all indications seem to be that the next tube of the water-cooled type will yield forty-five quanta per square millimeter in two and one-half microseconds, the average time duration of a single picture element. If the one-fifth second integration time of the eye is taken into consideration, this will yield approximately two hundred roentgen-ray quanta incident on the fluorescent screen after passing through some 25 centimeters of wet tissue. This particular link, i.e. the number of quanta incident on the fluorescent screen after passing through the object, is the weakest point statistically in the whole system, but this number of quanta will make the statistical fluctuation between regions of 100 per cent contrast, namely, between that of no roentgen rays and that region where the roentgen rays have passed through 25 centimeters of wet tissue of the order of 7 per cent. Figure 3 states the general case for this type of system and Figure 4 the

special case where the roentgen-ray beam is generated at a voltage of 100 kv. and a current of 100 ma. and the other factors have definite and known values.

In conclusion, I wish to thank the several persons who have worked with me these past three months so that we might today demonstrate to you the feasibility of this system. The success up to this point leads us to hope that we do have here something that can be developed into a practical means of amplifying the fluoroscopic image.

DR. FRED J. HODGES, Ann Arbor, Michigan. Statistical fluctuation mentioned so prominently by Dr. Sturm explains why, following two critically searching discussions of these four papers, time should be granted for remarks by one who lays no claim to mathematical or physical training. Perhaps I more nearly represent the majority of this audience than any of the previous speakers because my great interest in this subject of fluoroscopic image intensification is bolstered by great faith in its ultimate accomplishments. In my vast ignorance of the technical and theoretical difficulties to be overcome, I refuse to look with anything but enthusiastic confidence toward their ultimate complete solution.

The enthusiasm shown by Sturm and Morgan belies the note of gloom which they have sounded. Their remarks remind me of my former physics professor. Before every demonstration of classical physical phenomena, he used to express fervent hope that the experiment would be successful, knowing full well that it always would. If they were in serious doubt regarding the practical success of screen image amplification, their present furious experimentation would be abandoned promptly.

One is reminded of the difficulties, apparently insurmountable, which confronted photo-fluorography as recently as the mid-thirties. Ten years of energetic design, development of screens, films and lens systems plus extensive road-testing have given us a thoroughly practicable new technique. I for one expect nothing less gratifying from the various researchers who are striving for intensification success. We are living in a period of remarkable technical improvements in the tools of our profession. Screen intensification appears to be one of the most promising and important of these.

DR. MORGAN (closing). The hour is late and I shall do my best to sum up as quickly as possible.

Dr. Moon's experiments with the scanning roentgen tube are indeed very gratifying. Mr. Sturm and the rest of our group, as short a time as two weeks ago, finished a modified Moon system in which we used the conventional roentgen tube and an old type television scanning disc. We did this because we didn't have available to us the excellent facilities of the Rauland Corporation which Dr. Moon has.

Like Dr. Moon we were able to see, on the screen, images of very much the same quality that you saw on the viewing screen here this afternoon. Certainly, it is a method that is worth following up. It is an entirely feasible system from the technical standpoint; from the standpoint of ease and simplicity of construction, it does not offer the benefits of the tube which Mr. Coltman has talked about this afternoon.

There is also one other serious limitation with Dr. Moon's system which should be called to your attention at this time. It will be noted in Dr. Moon's Figure 4 that the roentgen-ray flux density at his pick-up fluorescent screen is 10^{11} roentgen-ray photons per square centimeter per second in the absence of an object. Now with a fluorescent screen, 4 inches square in size, this means that each square millimeter of the screen will receive 10^5 roentgen-ray photons per second. Also if one fluoroscopes an abdomen in the anteroposterior projection, this will reduce the number of roentgen-ray quanta to only 10^3 photons per square millimeter per second. Now this is exactly the number of photons which stimulate the eye in conventional present-day fluoroscopy. Therefore, according to the fluctuation theory that has been presented by Mr. Sturm this afternoon, Dr. Moon's system at best may be expected to be only as good as a conventional fluoroscope. Furthermore, these results can be obtained in Dr. Moon's system only with a fluoroscopic roentgen-ray generator operating at a constant potential of 100 kv. and 100 ma. (i.e. 10 kilowatts).

It may be argued, of course, that fluctuation theory is incorrect in estimating the detail provided by the Moon system. However, experimental measurements, which we have made with the system in our laboratory, justify confidence that the calculations are reasonably precise.

The inherent limitations of the Moon system seem insurmountable at this time. The pinhole diaphragm which is a fundamental part of the system discards so much of the radiation available from the roentgen-ray tube that an insufficient amount of radiation is available for good image quality. Accordingly, it appears that unless some completely unforeseen development takes place in the Moon system, image tubes like that described by Mr. Coltman will have considerably greater application in clinical fluoroscopy.

In answer to Dr. Hodges, who stated that we had caused a feeling of gloom to fall over this audience by anticipating that gains of only 30 to 50 or 60 times would be beneficial in the screen intensification process, we did so for a purpose. There has been a general feeling of great optimism as a result of the experimental work which you have heard about this afternoon. Indeed many people who have talked with me in the past few months have wondered whether or not they should buy any new roentgen-ray equipment. They felt that the new apparatus will so quickly revolutionize the entire field that the equipment that they have now will soon be obsolescent. We felt that a note of caution was in order.

I believe that the data that have been presented are sound and, contrary to the impression that Dr. Hodges apparently has received, we believe that the outlook is extremely gratifying. I think that Mr. Sturm in his paper expressed that opinion.

A gain of 30 to 50 times in brightness is a notable achievement. It will, as you saw in some of the curves, make the great mass of fluoroscopy which we will be pursuing in the future, as good as x-ray film; furthermore, even under the worst conditions, the situation will be immeasurably better than the situation that we now have today where experimental measurements indicate, for example, that the smallest object that can be perceived at 10 per cent contrast is of the order of one centimeter in diameter.

Certainly, we may expect much better performance than that. I feel that now that we have sounded our word of caution, we should leave this meeting with a note of optimism. The future for screen intensification is certainly bright, and very real benefits from screen intensification systems may be expected in a few years.

INFECTIOUS MONONUCLEOSIS*

WITH SPECIAL REFERENCE TO ROENTGENOLOGIC MANIFESTATIONS

By JAMES J. McCORT, M.D.

BOSTON, MASSACHUSETTS

THE first clinical description of infectious mononucleosis is credited to Filatow,¹⁶ a Moscow pediatrician, in 1885. Apparently unaware of this report, in 1889 Pfeiffer,²⁶ a pediatrician in Vienna, again described it and named it glandular fever because of the clinical signs of fever and lymph node enlargement. Neither of these observers recognized any specific changes in the blood. In 1905 Burns⁷ in Baltimore noted a peculiarity of the mononuclear cells in patients with glandular fever. His observations, as well as those made by European pediatricians, appeared to receive little attention during the ensuing years, and no series of cases were reported during the mobilization period of World War I. In 1920 Evans and Sprunt¹⁴ published a report of 6 cases of what they called infectious mononucleosis and described the blood changes in detail. Several years later Tidy³⁵ in England called attention to the fact that the two entities, glandular fever and infectious mononucleosis, were identical. Knowledge of the blood changes was amplified by the reports of Longcope²³ and of Downey and McKinley.¹¹ Based on the earlier work of Forssman,¹⁸ the discovery of Paul and Bunnell,²⁵ in 1932, that the serum of patients ill with the disease was capable of agglutinating the red blood cells of sheep in high dilution, the so-called heterophile antibody test, made available a ready and fairly accurate method of determining the presence of this disease.

PATHOLOGIC FINDINGS

Investigators have always been limited by a paucity of pathologic material due to the generally benign nature of infectious mononucleosis. In a study of 10 biopsied

lymph nodes, Gall and Stout¹⁹ found marked proliferative activity within the pulp and large numbers of specific infectious mononucleosis cells present throughout the nodes. The pathologic changes to be seen in the spleen, of which 9 were studied, were recorded by Smith and Custer.³² The spleen, which was enlarged in 8 out of the 9 cases, contained many normal and atypical lymphocytes which infiltrated the trabeculae and in some cases completely replaced the follicles.

Du Bois¹² in 1930 recorded the first autopsy of a case of infectious mononucleosis, that of a patient who died of empyema. The lungs when sectioned showed a confluent bronchopneumonia and a purulent bronchiolitis. It was impossible, however, to determine which, if any, changes were due to the infectious mononucleosis *per se*.

Thomsen and Vimtrup³⁴ in 1939 found 6 fatal cases among a total of 500 cases of infectious mononucleosis; these were described in detail, 2 of them having had postmortem examination. In one of the latter in which death was due to degenerative changes in the respiratory center of the brain, the mediastinal and mesenteric lymph nodes were enlarged, while the lungs were found to be edematous and hyperemic. Enlargement of the mediastinal and mesenteric lymph nodes was present also in the second autopsied case which had been complicated by a pneumococcic septicemia; the lungs were negative on microscopic study. In both cases there was enlargement of the lymph nodes around the common bile duct. Unfortunately no roentgenographic examination was made in any of the 6 cases.

In 1942 Jersild²¹ published a case report with postmortem examination of a patient

* From the Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts.

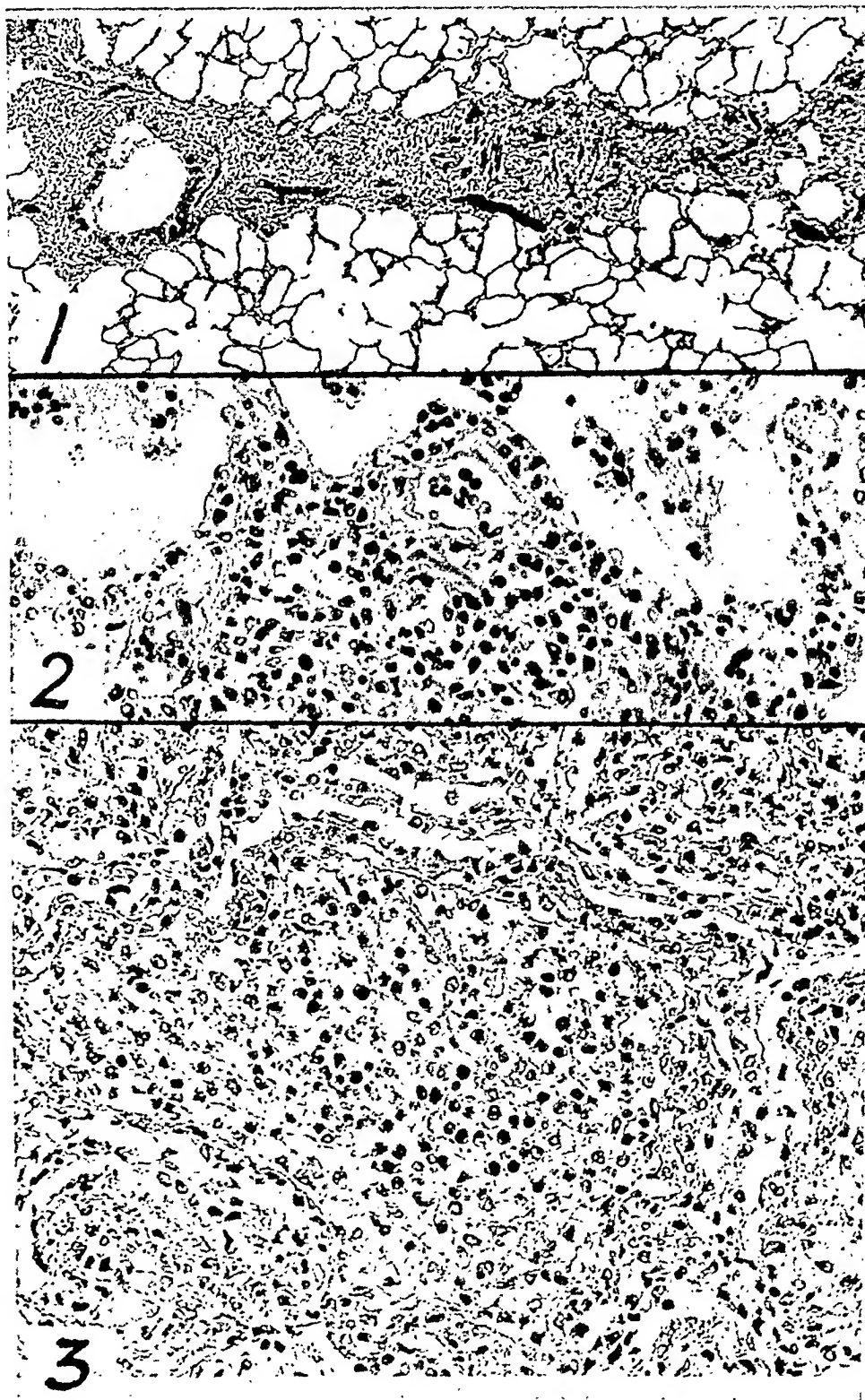


FIG. 1.* Lung. Peribronchovascular connective tissue and interlobar septum heavily "infiltrated" with lymphoid cells; the process involves intra-alveolar septa as well, rendering them thick and more prominent ($\times 30$).

FIG. 2.* Lung. Extensive interstitial pneumonitis with virtually no intra-alveolar exudate; the cellular reaction is entirely lymphocytic ($\times 450$).

FIG. 3.* Lung. Lobular pneumonia showing a rich fibrous network supporting a cellular exudate which is almost entirely of lymphoid type ($\times 450$).

* Figures 1, 2 and 3 reproduced through the courtesy of Custer and Smith,⁸ from *Blood*.

in whom the diagnosis had been substantiated by blood smear and the heterophile antibody test. A diffuse myocarditis was found to be the cause of death; the lungs were described as normal.

Subsequently there appeared a report of a single autopsy by Ziegler¹¹ in 1944. His patient died of a ruptured spleen ten days after admission to the hospital. Microscopic examination of the lungs showed capillary distention with atypical mononuclear cells as well as scattered perivascular and interstitial foci of mononuclear cells. There was also a moderate infiltration of the bronchial walls by the mononuclear cells.

The next publication on postmortem changes in infectious mononucleosis was that of Allen and Kellner² which appeared in 1947. In this case, during an acute attack of infectious mononucleosis, roentgenologic examination of the chest showed changes which were described as "primary atypical pneumonia, etiology unknown." About three weeks later the patient, an Air Force pilot, was killed in an airplane crash, and at autopsy focal cellular infiltrations of infectious mononucleosis cells were found in the lungs as well as in the liver, kidneys, heart, adrenals, testes, and brain.

In the same year Ricker *et al.*,³¹ on the basis of 2 cases studied clinically and at autopsy, called attention to the similarity of the neurologic manifestations of infectious mononucleosis to those of the Guillain-Barre syndrome, and postulated a probable causal relationship.

The most detailed study on the pathology of infectious mononucleosis to date is that of Custer and Smith⁵ published in 1948. Their material consisted of 9 cases from the files of the Army Institute of Pathology which included the single case of Allen and Kellner as well as the 2 cases of Ricker *et al.* Analysis of the lung changes in the 9 cases showed distinct lesions in 3; minimal lesions in 5; and no pulmonary abnormalities in 1. In some instances atypical mononuclear cells were found in the intra-alveolar septa in the manner seen in inter-

stitial pneumonitis (Fig. 1 and 2). Custer and Smith also found frank pneumonic consolidation in 2 cases; in one of which the cellular exudate was of the classical polymorphonuclear type while in the other the alveoli contained large numbers of atypical mononuclear cells (Fig. 3).

The most recently reported autopsy in infectious mononucleosis is that of Dolgopol and Husson¹⁰ in 1949 whose patient died nine days after the onset of the illness with respiratory paralysis, presumably due to a central nervous system lesion. No enlarged nodes were found in the hilar regions; atypical lymphocytes were present in the interstitial tissues of the lungs, beneath the mucosa, and in the pleura, but there was no interstitial pneumonitis.

MATERIAL

During the past six years a diagnosis of infectious mononucleosis has been made on 75 patients at the Massachusetts General Hospital. Of this group 43 had roentgenologic examination of the chest during their illness. A review of these roentgenograms shows that in 6 patients there were changes which it is believed could be attributed to the disease. These 6 cases and an additional similar one encountered during military service form the basis of this study. Definite hematologic evidence is available in all 7 patients establishing the diagnosis of infectious mononucleosis. That the pulmonary changes to be discussed are due to the disease is not definitely proved since all 7 made a spontaneous recovery with complete regression of the pulmonary abnormalities. Of the 43 whose chests were examined during the acute stage of their illness, 38 showed enlargement of peripheral lymph nodes clinically and 4 of these enlargement of the paratracheal or peribronchial lymph nodes roentgenologically. This does not necessarily mean, however, that the mediastinal nodes were not enlarged in any of the other 34 cases but rather that they were not sufficiently enlarged to be perceptible on the chest roentgenogram. In 4 of the 43 examined

roentgenologically there was also present a pneumonitis which later cleared completely.

INCIDENCE OF AND CLINICAL FINDINGS IN INFECTIOUS MONONUCLEOSIS

The clinical picture of infectious mononucleosis has been described adequately in the excellent monograph of Bernstein⁵ who summarized the world literature on the disease in 1940. The intervening period has been covered by Sturgis³³ in his textbook on hematology. Both authors found a definite age limit in patients suffering from this disease; it is one of children and young adults and is very unusual past the age of forty. The infection has a world wide distribution. It is said to be rare in the Negro race, but sporadic cases have been reported from time to time.⁴⁰ In general, the sex incidence is 3 to 2 in favor of males.

In a large series reported from an army post during World War II by Vander Meer *et al.*³⁷ the clinical manifestations appeared in the following order of frequency: malaise, cervical adenopathy, fever above 102°F., white blood cell count above 11,000, generalized aching, headache, and a spiking temperature curve. Milne²⁴ found sore throat a frequent complaint. On physical examination the lymphadenopathy is usually most striking although the nodes show only slight to moderate enlargement. They are discrete and often tender. Enlargement of the spleen, which is tender to palpation, occurs in about 50 per cent of the cases,³³ usually reaching to a few fingers-breadth below the costal margin, and in its distended condition may easily rupture. A note of warning against too vigorous palpation of this friable organ is sounded by Smith and Custer.³² Palpation with its consequent danger may be avoided by roentgenography; a plain film of the upper abdomen, centered over the hypochondrium, gives adequate information. In the present group, 12 patients showed a splenic enlargement that was apparent on the chest roentgenogram.

In monocytic angina or the angiose type

of infectious mononucleosis, examination may also disclose a tonsillar membrane or ulceration. Jaundice has been found in 9.1 per cent of 64 patients studied by Abrams.¹

LABORATORY DATA

The diagnosis of infectious mononucleosis is usually suspected when the blood examination is complete and the blood smear studied. An initial polymorphonucleosis with as high as 75 per cent polymorphonuclear cells is said to be not infrequent.³⁶ During the course of the illness a monocytic and lymphocytic reaction follows, at which time there is an absolute rise of these cells with many atypical forms. The importance of the heterophile antibody test as corroborative diagnostic evidence has already been noted. This test is made more accurate by absorption tests with beef cells and guinea pig kidney.¹⁷ The test does not become positive until several days after the onset of the disease or even later. Paul and Bunnell²³ are of the opinion that a positive reaction is proof of infectious mononucleosis and that a negative reaction does not exclude it. The heterophile antibody test is also positive in serum sickness. The frequent finding of a falsely positive Wassermann reaction during the active stages of infectious mononucleosis as in other infections has been noted.³³

ROENTGENOLOGIC PULMONARY CHANGES

That enlargement of the mediastinal lymph nodes occurred in infectious mononucleosis was suspected by both Filatow and Pfeiffer, as shown in their early clinical descriptions of the disease, and later by others,²³ on the basis of the patient's non-productive cough. It is reasonable to expect that a disease causing enlargement of the peripheral lymph nodes might bring about a similar change in the mediastinal and mesenteric lymph nodes. Not all cases of infectious mononucleosis present peripheral adenopathy, but when it is present, roentgenologic evidence of similar enlargement of the mediastinal nodes would not be unex-

pected. Unfortunately, roentgenographic examination of the chest is not a routine procedure in this disease, and the actual incidence of this finding is very low. Even when a chest examination is made, mitigating against the discovery of nodal enlargement is the fact that the mediastinum

ment of the mediastinal lymph nodes (Fig. 4, 5 and 6).

Changes in the peripheral lung fields have been observed. Based on the studies of Custer and Smith these are believed to be due to an interstitial infiltration or an alveolar filling by the atypical lymphocytes,

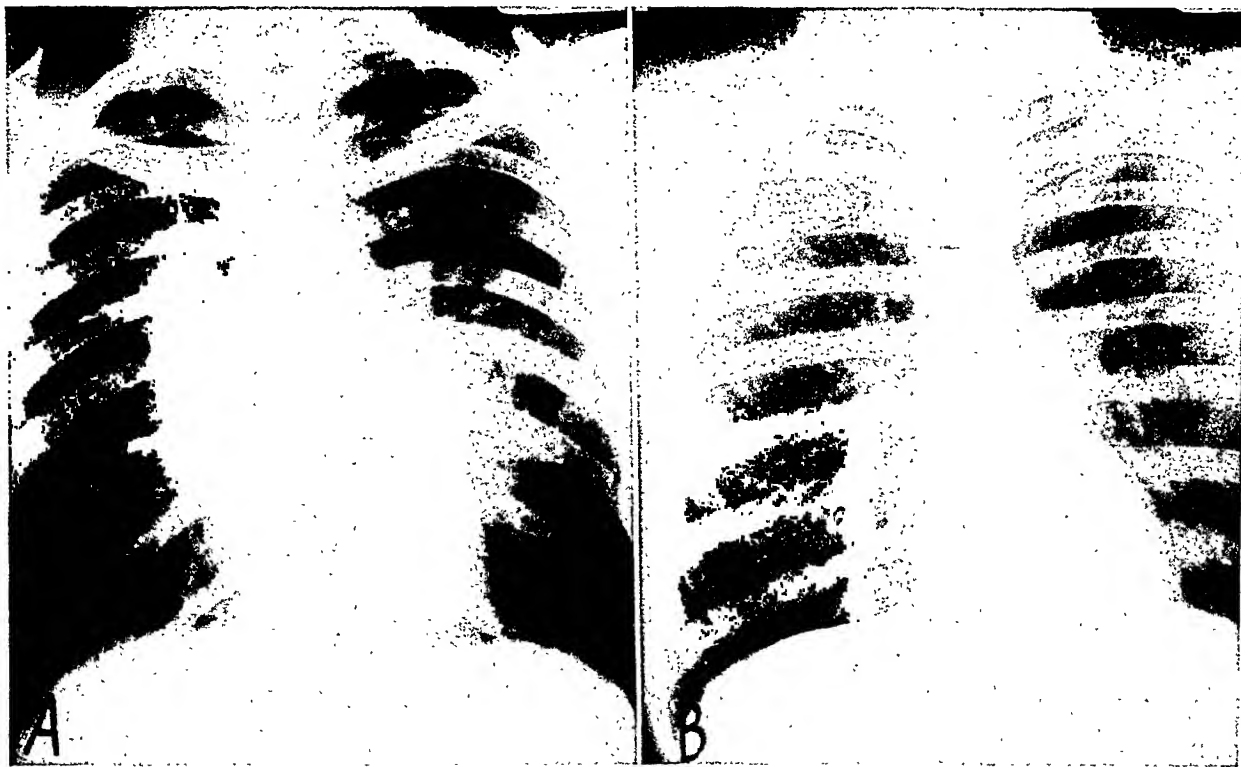


FIG. 4. W. J. S., a twenty-one year old white enlisted man, was admitted to an Army general hospital complaining of headache, cough and fever of 101°F ., present for several days. Four days after admission the cervical, axillary and inguinal lymph nodes were found to be enlarged and the spleen was palpable. *Laboratory data:* Red blood cell count, 5,450,000; white blood cell count, 15,000, with 23 per cent polymorphonuclears, 73 per cent lymphocytes, 4 per cent monocytes, many prolymphocytes; hemoglobin, 17.4 gm. Heterophile antibody positive 1:512; Kahn test positive (? false positive); tuberculin test negative 1:10,000 forty-eight hours; coccidioidin test negative, forty-eight hours; sputum negative for acid fast bacilli.

(A) Roentgenogram shows a marked enlargement of peribronchial lymph nodes with a strand-like increase in density in both lungs. (B) Roentgenogram taken three months later shows complete clearing of the periphery and regression of the enlarged nodes. (Clinically recovery was complete.)

and superimposed structures are composed of dense tissues and the nodes, to be visible, must be greater than 2 to 3 cm. in diameter in order to project outside the margins of the vascular shadows. Press *et al.*²⁹ reported 3 instances of enlargement of the mediastinal nodes out of a group of 96; single instances in smaller groups have been described by others.^{4,15,22,23} Of the 7 patients in the present series with roentgenologic changes, 5 showed detectable enlarge-

ment of the mediastinal lymph nodes (Fig. 4, 5 and 6). Changes in the peripheral lung fields have been observed. Based on the studies of Custer and Smith these are believed to be due to an interstitial infiltration or an alveolar filling by the atypical lymphocytes,

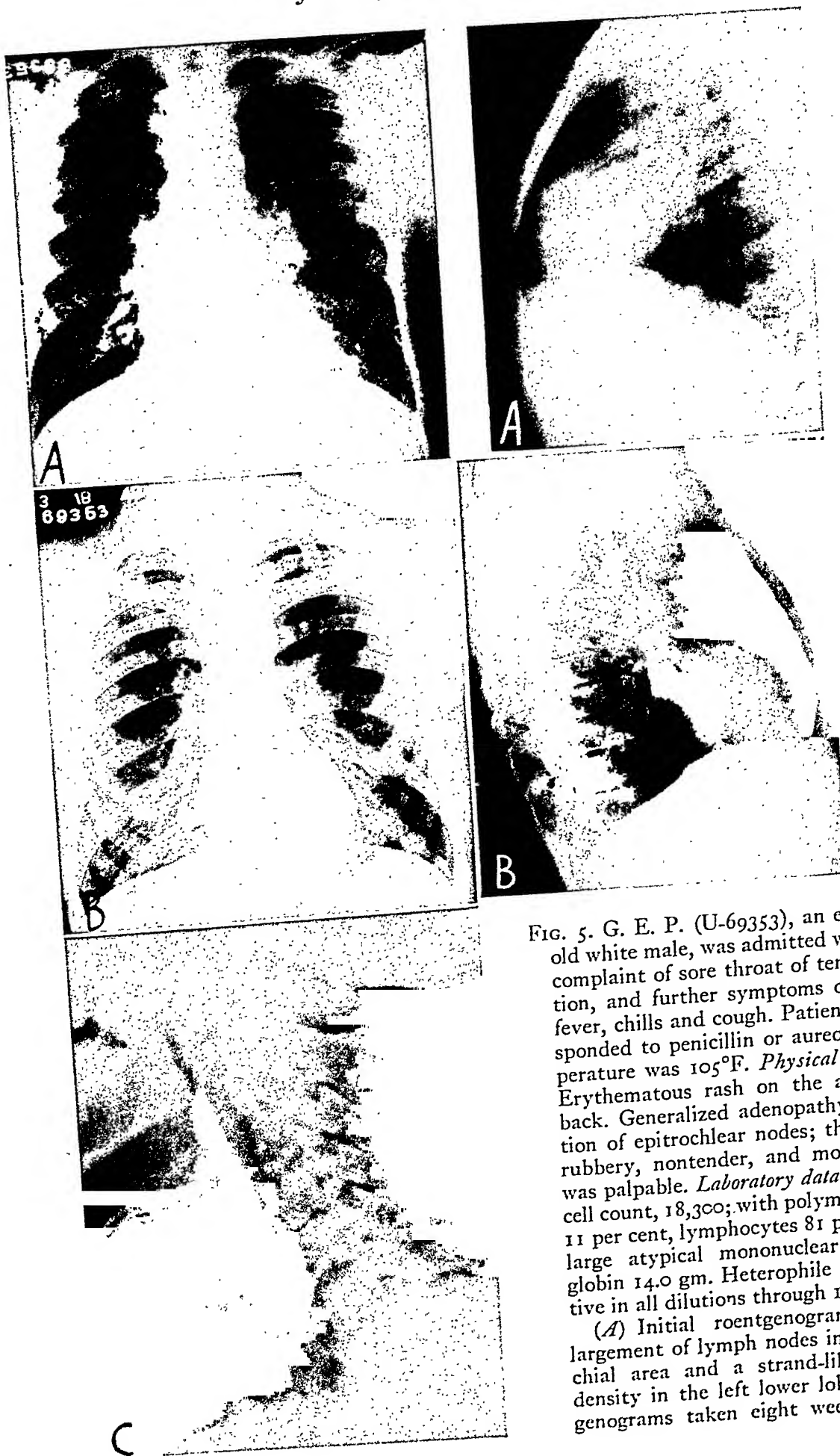


FIG. 5. G. E. P. (U-69353), an eighteen year old white male, was admitted with the chief complaint of sore throat of ten days' duration, and further symptoms of dysphagia, fever, chills and cough. Patient had not responded to penicillin or aureomycin. Temperature was 105°F . *Physical examination:* Erythematous rash on the abdomen and back. Generalized adenopathy with exception of epitrochlear nodes; the nodes were rubbery, nontender, and movable. Spleen was palpable. *Laboratory data:* White blood cell count, 18,300; with polymorphonuclears 11 per cent, lymphocytes 81 per cent; many large atypical mononuclear cells; hemoglobin 14.0 gm. Heterophile antibody positive in all dilutions through 1:128.

(A) Initial roentgenograms show enlargement of lymph nodes in left peribronchial area and a strand-like increase in density in the left lower lobe. (B) Roentgenograms taken eight weeks later show



FIG. 6. M. D., Jr. (U-637616), a fifteen year old white male, was admitted complaining of malaise and difficulty in swallowing. *Physical examination*: Small tender lymph nodes in the cervical, axillary, inguinal and epitrochlear regions. The spleen was barely palpable. *Laboratory data*: White blood cell count, 17,000, with 66 per cent polymorphonuclears and 34 per cent lymphocytes. There were several atypical forms of both the lymphocytic and monocyctic series. Heterophile antibody positive 2 plus in a dilution of 1:128.

(A) Roentgenograms on admission show enlarged lymph nodes in the left hilum; the lungs are otherwise clear. (B) Examination made five months later shows the lymph nodes to have regressed completely.

diminution in size of the lymph nodes and partial resolution of the process in the left lower lobe. (C) Lateral examination of the neck, made on admission, shows enlargement of the lingual tonsils and swelling of the epiglottis, which probably account for the complaint of sore throat and dysphagia.

seen at Johns Hopkins Hospital by Bernstein⁵ clinical signs of bronchopneumonia were found. Boquien and Vercelletto⁶ observed tiny nodular densities in the lung parenchyma during the course of the disease in 1 case; this seems to be unusual and no similar cases are known to have

In 5 of the 7 cases in this study changes were found in the pulmonary parenchyma (Fig. 4, 5 and 7). In 3 of these the parenchymal changes were associated with mediastinal lymph node enlargement. In none of the 5 patients did the clinical course bear a great resemblance to atypical or bacterial

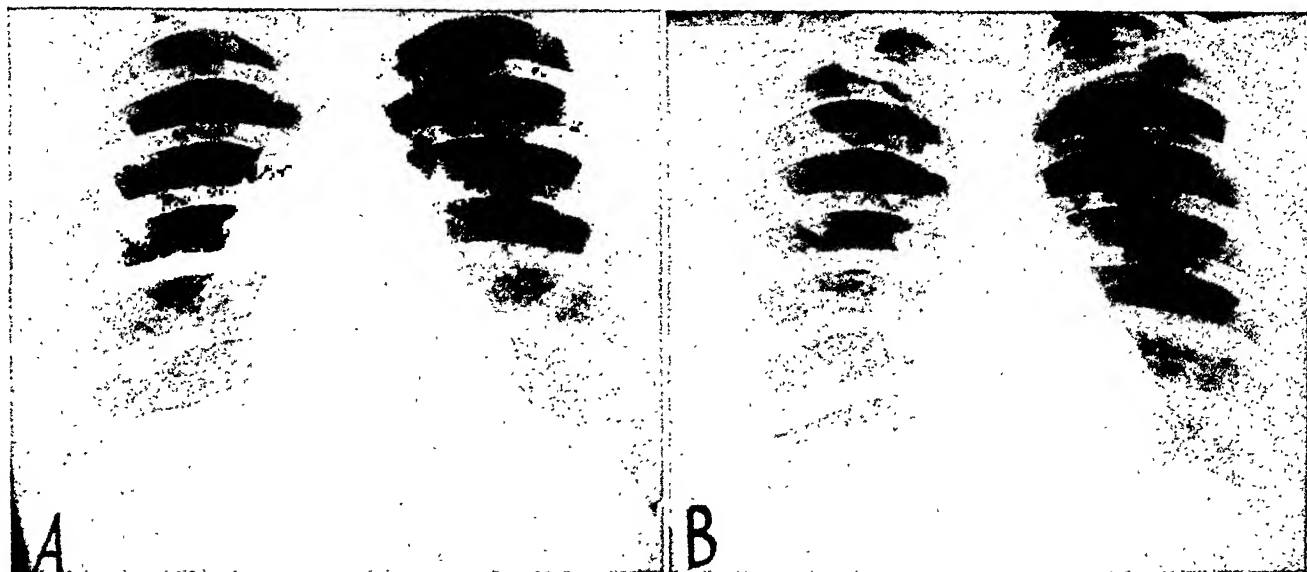


FIG. 7. E. T. (U-453411), an eighteen year old white student nurse, developed malaise one week before admission and five days before complained of generalized aches and pains, and anorexia followed by headache, nausea and cough. *Physical examination:* Patient was feverish but in no acute distress. Enlarged lymph nodes were palpable on both sides of the neck.

(A) Examination of chest on admission shows a pneumonitis in the left base. *Laboratory data:* White blood cell count, 10,400, with 52 per cent polymorphonuclears, 38 per cent large lymphocytes, and 6 per cent small lymphocytes. Heterophile antibody 1 plus in dilution of 1:32. (B) Chest examination one week later shows complete resolution of the pneumonitis in the left base. *Laboratory data:* White blood cell count, 17,000, with 20 per cent polymorphonuclears, 2 per cent large lymphocytes, 36 per cent small lymphocytes and 1 per cent monocytes, atypical lymphocytes 34 per cent. Heterophile antibody positive 1:64.

been reported. Two patients with clinical signs of pleurisy were seen in an "epidemic" of 84 cases reported by Raeburn,³⁰ and a sterile pleural effusion was found in a patient described by Power and Boucher.²⁸

In the previously mentioned autopsied case of Allen and Kellner,² as well as in 14 out of 556 cases of Wechsler *et al.*,³⁹ roentgen changes in the lung were described as "similar to primary atypical pneumonia, etiology unknown." The roentgenologic similarity is understandable on the basis of the pathologic studies of Custer and Smith, which indicate that in some cases the microscopic changes of interstitial infiltration can be caused by atypical lymphocytes and monocytes in infectious mononucleosis (see Fig. 1 and 2).

pneumonia, nor was the pneumonitis suspected clinically. It was an incidental finding on the chest roentgenogram, and its true character is unproved; it is possible, however, that it represents pulmonary changes associated with the infectious mononucleosis process. In this small group the speed of resolution of the pulmonary changes varied,—in one patient the lungs were entirely clear one week after the initial examination; in another it was very slow, the lungs not clearing completely until three months after the initial roentgenogram.

An interesting report by Poppel and Starr²⁷ appeared in 1942. In one of their cases small pressure defects were seen on the wall of the second portion of the

duodenum; this they attributed to lymph node enlargement although they were unable to prove this hypothesis. Similar defects were seen in one of the cases in this series. These findings gain importance in the light of the 2 autopsies reported by Thomsen and Vimtrup³⁴ in both of which enlargement of the lymph nodes surrounding the common duct was found.

DIFFERENTIAL DIAGNOSIS

Very little difficulty is encountered in establishing the diagnosis of infectious mononucleosis. An adenopathy occurring in a young person with splenomegaly, fever, malaise, and sore throat usually raises the suspicion, which is strengthened by an abnormal blood smear, and confirmed by a rising blood titer of sheep red blood cell agglutinins. The roentgen evidence of mediastinal lymphadenopathy must be differentiated from that associated with other diseases, particularly lymphoma, leukemia, sarcoid, erythema nodosum, coccidioidomycosis, and primary tuberculosis. This differentiation can be made only by correlation with the clinical history and findings. As previously mentioned, the pulmonary parenchymal changes resemble atypical pneumonia or other virus infection. Perhaps in the future a therapeutic trial of aureomycin may be of value as a differential procedure.

COMPLICATIONS

Infectious mononucleosis, a benign, self-limited disease, has very few complications. Of these the most formidable is that of splenic rupture, and this is responsible for the majority of deaths so far reported in the literature. Other complications that have been recorded are hemolytic anemia,³ thrombocytopenic purpura,^{9,40} central nervous system involvement,^{10,31,36,38} myocarditis,²¹ and hepatitis with jaundice.¹ Relapses occur in a certain number of cases, and a chronic state of the disease has been described.²⁰

SUMMARY

Of seventy-five cases of infectious mononucleosis treated at the Massachusetts

General Hospital, forty-three have had roentgen examination of the chest during the course of the disease.

In seven cases of clinically proved infectious mononucleosis, roentgen examination showed the following:

1. Enlargement of the mediastinal lymph nodes in two cases.
2. Both enlargement of the mediastinal lymph nodes and pulmonary parenchymal changes in three cases.
3. Parenchymal changes only in two cases.

Positive changes on a chest roentgenogram in infectious mononucleosis are infrequent. On the basis of published pathologic studies, it is suggested that pulmonary changes when present are due to engorgement of the hilar lymph nodes and infiltration of the interstitial tissue of the lung by atypical lymphocytes and monocytes.

Massachusetts General Hospital
Boston 14, Mass.

REFERENCES

1. ABRAMS, H. L. Infectious mononucleosis with intense jaundice of long duration. *New England J. Med.*, 1948, 238, 295-299.
2. ALLEN, F. H., JR., and KELLNER, A. Infectious mononucleosis; autopsy report. *Am. J. Path.*, 1947, 25, 463-477.
3. APPLEMAN, D. H., and MORRISON, M. M. Concomitant infectious mononucleosis and hemolytic icterus. *Blood*, 1949, 4, 186-188.
4. BASS, M. H., and HERMAN, H. Infectious mononucleosis in childhood. *Med. Clin. North America*, 1925, 9, 589-599.
5. BERNSTEIN, A. Infectious mononucleosis. *Medicine*, 1940, 19, 85-159.
6. BOQUIEN, Y., and VERCELLETTO. Mononucléose infectieuse et image pulmonaire micronodulaire avec réactions tuberculiniques négatives. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1946, 62, 456-457.
7. BURNS, J. E. Glandular fever. *Arch. Int. Med.*, 1909, 4, 118.
8. CUSTER, R. P., and SMITH, E. B. Pathology of infectious mononucleosis. *Blood*, 1948, 3, 830-857.
9. DAMESHEK, W., and GRASSI, M. A. Infectious lymphadenosis ("mononucleosis") and thrombocytopenic purpura; recovery after splenectomy. *Blood*, 1946, 1, 339-342.
10. DOLGOPOL, V. B., and HUSSON, G. S. Infectious mononucleosis with neurologic complications. *Arch. Int. Med.*, 1949, 83, 179-196.

11. DOWNEY, H., and MCKINLEY, C. A. Acute lymphadenosis compared with acute lymphatic leukemia. *Arch. Int. Med.*, 1923, 32, 82-112.
12. DU BOIS, A. H. De la pathogénie de l'angine à monocytes. *Acta med. Scandinav.*, 1930, 73, 237-259.
13. ERF, L. A. Acute infectious mononucleosis with unidentified structures in supravital preparations of lymph nodes. *J. Mt. Sinai Hosp.*, 1936, 3, 113-117.
14. EVANS, F. A., and SPRUNT, T. P. Mononuclear leucocytosis in reaction to acute infections. *Bull. Johns Hopkins Hosp.*, 1920, 31, 410.
15. FARLEY, D. L. Acute infectious mononucleosis. *Med. Clin. North America*, 1937, 21, 1139-1151.
16. FILATOW, N. Vorlesungen über acute infectiösen Krankheiten im Kindesalter. Second edition. Josef Sofar, Wien, 1897.
17. FOORD, A. G., and BUTT, E. M. Laboratory diagnosis of infectious mononucleosis. *Am. J. Clin. Path.*, 1939, 9, 448-464.
18. FORSSMAN, I. Die Herstellung hochwertigen spezifischer Schafhämolytins ohne Verwendung von Schafblut. Ein Beitrag zur Lehre von heterologer Antikörperbildung. *Biochem. Ztschr.*, 1911, 37, 78-115.
19. GALL, E. A., and STOUT, H. A. Histological lesion in lymph nodes in infectious mononucleosis. *Am. J. Path.*, 1940, 16, 433-448.
20. ISAACS, E. B. Chronic infectious mononucleosis. *Blood*, 1948, 3, 858-861.
21. JERSILD, T. Fatal case of infectious mononucleosis. *Nord. med. (Hospitalltid.)*, 1942, 14, 1705-1706.
22. LANGE, J. Lymphemoid glandular fever. *Norsk, mag. f. laegevidensk.*, 1934, 95, 32-50. (Abs. *J.A.M.A.*, 1934, 102, 1888.)
23. LONGCOPE, W. T. Infectious mononucleosis (glandular fever) with a report of 10 cases. *Am. J. M. Sc.*, 1922, 164, 781-808.
24. MILNE, JOHN. Infectious mononucleosis. *New England J. med.*, 1945, 233, 727-731.
25. PAUL, J. R., and BUNNELL, W. W. Presence of heterophile antibodies in infectious mononucleosis. *Am. J. M. Sc.*, 1932, 183, 90-104.
26. PFEIFFER, E. Drüsenfieber. *Jahrb. f. Kinderh.*, 1889, 29, 257-264.
27. POPPEL, M. H., and STARR, S. Roentgen manifestations of acute infectious mononucleosis in abdomen. *Radiology*, 1942, 39, 437-439.
28. POWER, P., and BOUCHER, F. T. Some notes on two cases of glandular fever. *J. Roy. Army M. Corps*, 1931, 56, 293-298.
29. PRESS, J. H., SHLEVIN, E. L., and ROSEN, A. P. Infectious mononucleosis; study of 96 cases. *Ann. Int. Med.*, 1945, 22, 546-562.
30. RAEBURN, C. Glandular fever, B.A.O.R., 1945. *J. Roy Army M. Corps.*, 1946, 87, 78-80.
31. RICKER, W., BLUMBERG, A., PETERS, C. H., and WIDERMAN, A. Association of Guillain-Barresyndrome with infectious mononucleosis, with report of 2 fatal cases. *Blood*, 1947, 2, 217-226.
32. SMITH, E. B., and CUSTER, R. P. Rupture of spleen in infectious mononucleosis; clinicopathologic report of 7 cases. *Blood*, 1946, 1, 317-333.
33. STURGIS, C. C. Hematology. Charles C Thomas, Springfield, Illinois, 1948, pp. 640-665.
34. THOMSEN, S., and VIMTRUP, B. Six fatal cases of infectious mononucleosis complicated by central respiratory paralysis. *Nord. med. (Hospitalltid.)*, 1939, 4, 2395-2399.
35. TIDY, H. Glandular fever and infectious mononucleosis. *Lancet*, 1923, 2, 205.
36. TIDY, H. Infectious mononucleosis. *Blood*, 1948, 3, 823-829.
37. VANDER MEER, R., LUTTERLOH, C. H., and PILOT, J. Infectious mononucleosis; analysis of 26 clinical and 340 subclinical cases. *Am. J. M. Sc.*, 1945, 210, 765-774.
38. VAUGHAN, S. L., REGAN, J. S., and TERPLAN, K. Infectious mononucleosis complicated by spontaneous rupture of spleen and central nervous system involvement. *Blood*, 1946, 1, 334-338.
39. WECHSLER, H. F., ROSENBLUM, A. H., and SILLS, C. T. Infectious mononucleosis; report of epidemic in army post. *Ann. Int. Med.*, 1946, 25, 113-129; 236-265.
40. WILSON, S. J., WARD, C. E., and GRAY, L. W. Infectious lymphadenosis and hemolytic anemia in a negro; recovery following splenectomy. *Blood*, 1949, 4, 189-192.
41. ZIEGLER, E. E. Infectious mononucleosis; report of fatal case with autopsy. *Arch. Path.*, 1944, 37, 196-201.



THE ANGIOCARDIOGRAPHIC DIAGNOSIS OF SYPHILITIC AORTITIS*†

By ISRAEL STEINBERG, M.D., CHARLES DOTTER, M.D., GEORGE PEABODY, M.D.,
GEORGE READER, M.D., LEONARD HEIMOFF, M.D., and BRUCE WEBSTER, M.D.

NEW YORK, NEW YORK

SYPHILITIC aortitis may be considered the fundamental lesion of cardiovascular syphilis in that saccular aneurysm, aortic insufficiency and coronary artery disease develop secondarily to it. As might be expected, uncomplicated syphilitic aortitis is also the commonest form of cardiovascular syphilis. Moore estimates that 70 to 90 per cent of all patients with late syphilis detectable at postmortem examination show evidence of cardiovascular damage, usually syphilitic aortitis.¹

Saccular aneurysm, insufficiency of the aortic valve and coronary ostial atresia can be altered relatively little by anti-syphilitic therapy, but the application of specific therapy to uncomplicated aortitis can be expected to result in arrest of the inflammatory process and prevention of more serious lesions.² The ideal management of cardiovascular syphilis is generally agreed to be its detection and treatment in the stage of uncomplicated aortitis, and considerable effort has been expended to improve the means for early diagnosis. The yearly physical examination of the patient with late latent syphilis is mainly for the purpose of detecting the earliest signs of involvement of the cardiovascular system.

CONVENTIONAL METHODS OF DIAGNOSIS

Uncomplicated syphilitic aortitis is rarely productive of symptoms. Aortalgia, a burning substernal pain, has been described, but its inconstancy makes it a most unreliable criterion. Physical signs are of little more diagnostic value since they can be produced by hypertension and arteriosclerosis, both of which commonly occur in the same

age range as syphilitic aortitis. Emphasis has been placed on the quality of the aortic second sound, a tambour-like accentuation being pointed to as evidence of aortitis. Similar sounds are so often produced by arteriosclerosis and hypertension as to render this sign of doubtful differential value. Percussion of the chest is also unreliable in that widening of the area of supracardiac dullness occurs rarely in uncomplicated aortitis and usually indicates the presence of aneurysm.

Roentgenography and roentgenoscopy of the chest have been of considerable value in detecting cases of uncomplicated aortitis and differentiating them from other types of cardiovascular disease.³ Calcification of the ascending aorta has been found to be a relatively reliable sign of syphilitic aortitis; however, its presence is not pathognomonic and its absence is of no diagnostic significance. Obvious widening of the aorta is significant, but does not occur frequently enough to be used as a diagnostic criterion and is usually a late manifestation by the time it becomes evident on conventional roentgen examination. The portion of the aorta most commonly affected by syphilis is the ascending portion which is hidden by the heart in the conventional chest roentgenogram. Various measurements of aortic width have been shown to be indirect, inaccurate and inapplicable to the root of the aorta where the earliest manifestations of syphilitic aortitis occur.^{4,5}

A positive serological test for syphilis, a history of antisyphilitic therapy or collateral evidence of syphilis on physical examination, plus widening of the aorta, calcification of the ascending aorta, evidence of

* From the Department of Radiology and the Department of Medicine of the New York Hospital—Cornell Medical Center. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

† This investigation was aided by a grant from the Schering Corporation.

aneurysm or the presence of the diastolic murmur of aortic insufficiency have been considered sufficient to make a diagnosis of cardiovascular syphilis. It has been difficult to detect early cases of syphilitic aortitis and occasionally to differentiate between syphilitic and hypertensive or arteriosclerotic disease.

ANGIOCARDIOGRAPHY

Angiocardiography affords exact visualization of the gross structure of the thoracic aorta during life. Utilizing the method of

(A) the mid-ascending aorta, (B) the transverse aorta, (C) the mid-descending aorta, and (D) the diaphragmatic aorta (Fig. 2*b*). Measurements in this series of 60 cases of syphilitic aortitis were compared to corresponding measurements of a hundred normal aortas. A summary of the results is presented in Table I, and a graphic comparison of the caliber of the normal and syphilitic mid-ascending aorta may be seen in Figure 1. Measurements of the ascending aorta in the presence of syphilitic aortitis in 51 of our cases varied from 38 to

TABLE I

TABLE SHOWING COMPARATIVE MEASUREMENTS MADE ON 100 NORMAL AORTAS (INCLUDING ARTERIOSCLEROSIS) AND 60 CASES OF SYPHILITIC AORTITIS.

Aorta	Normal			Syphilitic		
	No. Cases	Range mm.	Average mm.	No. Cases	Range mm.	Average mm.
Ascending	100	16-38	28.6	51	38-70	45.4
Transverse	44	13-34	24.8	39	25-49	32.3
Descending	58	12-32	22.9	30	24-50	31.3
Diaphragm	54	9-28	19.7	18	20-43	28.2

Robb and Steinberg,⁶ the angiocardiographic characteristics of syphilitic aortitis were studied. It was found that in the presence of clinical or roentgen evidence of aortitis, and occasionally in their absence, certain angiocardiographic signs were regularly present. These signs, critically evaluated in 60 cases, included aortic dilatation, irregularity of aortic lumen, calcification of the ascending aorta, aortic tortuosity, abnormal aortic wall thickness, and aneurysm.

Dilatation. Dilatation is the most significant angiocardiographic evidence of syphilitic aortitis, varying from slight enlargement of the ascending aorta to widespread dilatations or saccular aneurysm. A previous report has outlined in detail a method for measurement of the angiocardiographically visualized aorta.⁵ Briefly, these measurements are made in the left anterior oblique projection at four points:

70 mm., and averaged 45.4 mm. in caliber, as compared to a normal range of from 16 to 38 mm. with an average of 28.6 mm., all ages being considered. In syphilitic aortitis, the transverse, descending and diaphragmatic measurements were similarly higher than the corresponding normal figures, but the incidence and degree of dilatation diminished as the point of measurement left the proximal aorta, a fact in agreement with the pathological evidence that the ascending aorta is the earliest affected in syphilitic aortitis.

In the presence of syphilis and in the absence of other detectable causes for aortic widening, dilatation of the aorta may be considered diagnostic of syphilitic aortitis. However, it is not in itself pathognomonic of syphilitic aortic disease. We have repeatedly observed abnormal dilatations of the ascending aorta (over 38 mm.) in the presence of hypertension, rheumatic aortic

valvular insufficiency and coarctation of the aorta. We have never observed aortic dilatation above the upper limit of normal which could be attributed to arteriosclerosis alone. Hypertension and syphilis often co-exist, occasionally making the interpretation of aortic dilatation difficult. No cases were included in this series when other potential causes of aortic dilatation cast

Irregularity of Lumen. Non-syphilitic aortic dilatation tends to be uniform and smooth in outline. The dilated, unfolded lumen of the hypertensive aorta shows diffuse rather than local dilatation, and although as in syphilis the maximum dilatation is that of the mid-ascending aorta, the transition to a normal width occurs gradually throughout the entire aortic arch. In

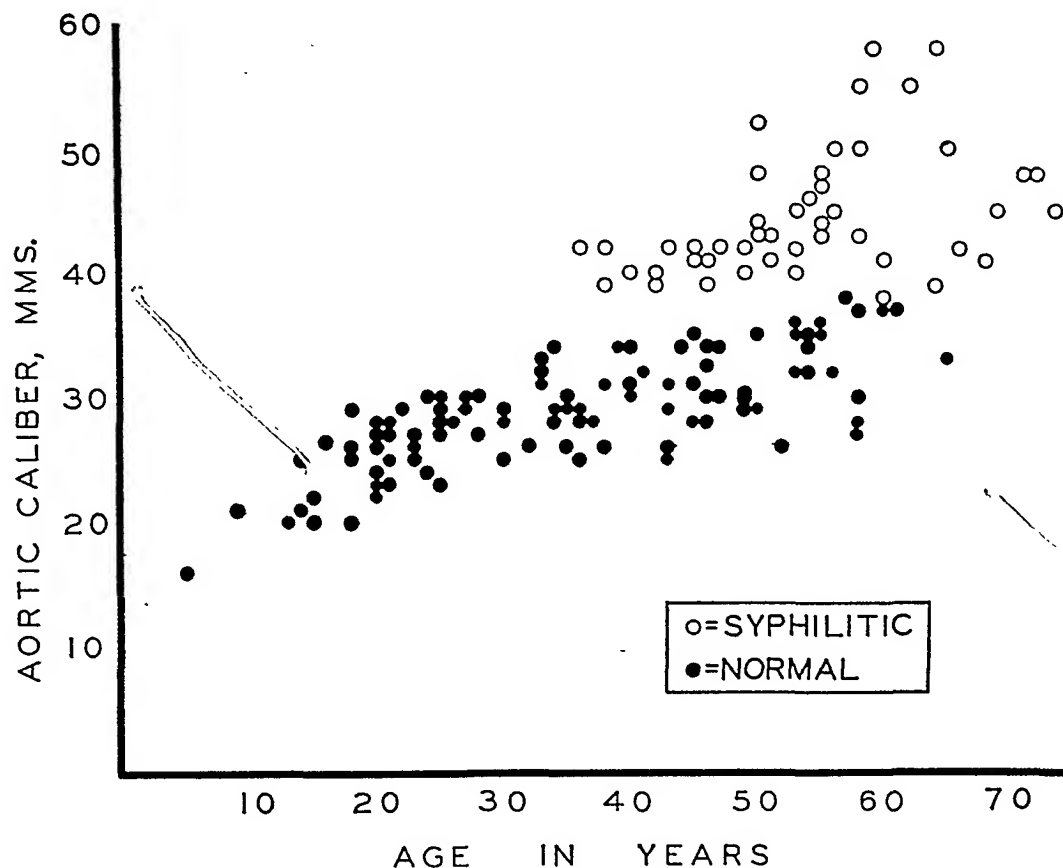


FIG. 1. Graphic representation of caliber of mid-ascending aorta in 100 normal aortas (solid black dots) and 46 cases of syphilitic aortitis (circles). Arteriosclerosis considered as "normal."

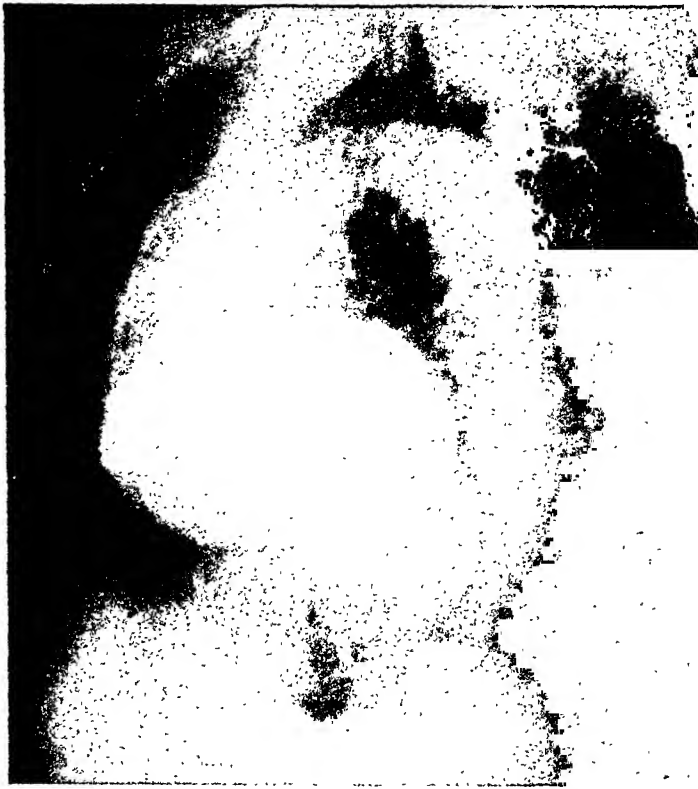
doubt upon the diagnosis of syphilitic aortitis. Conversely, the absence of aortic dilatation does not exclude the presence of aortitis since histopathologic changes in the aortic media occur in the absence of gross aortic dilatation early in the course of the disease. In assembling this series of cases, several cases with clinical evidence suggesting syphilitic aortitis were excluded in the absence of angiocardiographic evidence of aortic dilatation. Two of these excluded cases in the middle age group had calcification of the ascending aorta and probably had syphilitic aortitis.

syphilitic aortitis, the caliber of the aorta may be seen to vary in a more irregular fashion, a finding of definite differential value. The presence of an irregular aortic lumen was noted in 51 (95 per cent) of our cases.

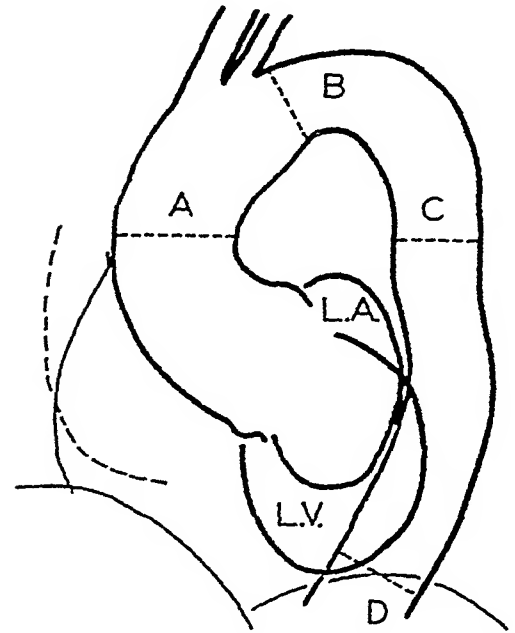
Calcification of the Ascending Aorta. In this series, roentgenographic evidence of calcification of the ascending aorta was present in 16 cases (26.6 per cent), a figure comparable to that reported by Jackman and Lubert⁷ in an analysis of 66 proved cases of syphilitic aortitis. We have observed calcification of the ascending but

not the descending aorta in instances where there was no clinical or angiocardigraphic evidence of syphilis. The absence of calcification of the ascending aorta is thus of no significance in ruling out syphilitic aortitis, while its presence may be considered presumptive but not pathognomonic evidence of the disease.

As demonstrated angiocardigraphically were occasionally striking, these findings, on the whole, are regarded as inconclusive. Atherosclerotic plaques cause abnormal aortic wall thickness. Assuming the normal aortic wall thickness to be approximately 2 mm., we have observed abnormally thick and thin walls at and between



a



b

FIG. 2a. Angiocardigraphic study of aorta (left anterior oblique projection) of a fifty-three year old female upon whom the clinical but not the roentgen diagnosis of syphilitic aortitis had been made. Note dilatation, irregularity, and tortuosity of ascending aorta and aortic arch. No calcification was present.

FIG. 2b. Tracing of Figure 2a. Routine sites of measurement: (A) mid-ascending (43 mm.); (B) transverse (27 mm.); (C) mid-descending (30 mm.); (D) diaphragmatic (32 mm.).

Aortic Tortuosity. In 51 (95 per cent) of our cases, there was demonstrable tortuosity of the aorta. Since the age groups of syphilis and arteriosclerosis are widely overlapping and since arteriosclerosis generally produces tortuosity of the aorta, this finding is of relatively little value. It becomes of considerable diagnostic significance, however, in the younger age group, as does the presence of calcification in the aortic arch, regardless of its location.

Variations in Aortic Wall Thickness. Although variations in thickness of the aortic

areas of dilatation in aortitis. Aneurysm walls were seen to vary between 1 and 15 mm. in thickness, the latter figure probably reflecting the combined presence of laminated thrombus and scar tissue.

Aneurysm. Aortic aneurysms, while occasionally non-syphilitic in nature, are generally regarded as diagnostic of aortic syphilis. Angiocardigraphy makes the recognition of aortic aneurysm a relatively simple procedure. Of our 60 cases, 25 patients had aortic aneurysms, of which 7 were multiple aneurysms, 18 were saccular

aneurysms, 7 were fusiform aneurysmal dilatations. Arbitrarily, we consider a diffuse fusiform dilatation of the aorta aneurysmal if its maximum caliber exceeds 60 mm.

DISCUSSION

In revealing clearly the gross anatomy of the entire thoracic aorta, angiocardiography greatly facilitates the diagnosis of syphilitic aortitis. The earliest and most constant angiocardiographic sign of syphilitic aortitis is dilatation of the ascending aorta which although highly suggestive is not pathognomonic since it may be caused by other pathologic processes, notably hypertension and rheumatic aortic insufficiency. In the presence of syphilis and in the absence of hypertension or rheumatic aortic valvular disease, the diagnosis of syphilitic aortitis may be made angiocardiographically even in the absence of clinical or conventional roentgenographic signs. Early dilatation of the ascending aorta cannot be detected with regularity by conventional roentgenographic means. The angiocardiographic diagnosis of syphilitic aortitis in the absence of aortic dilatation should not be made. Other commonly encountered angiocardiographic evidences of syphilitic aortitis include irregularity of the aortic lumen, calcification in the ascending aorta, aortic tortuosity, variations in aortic wall thickness and aneurysm. A typical case of syphilitic aortitis is illustrated in Figure 2, *a* and *b*.

Since angiocardiography is occasionally inadequate diagnostically, the diagnosis of syphilitic aortitis should always be based upon a careful evaluation of history, physical findings and roentgen examination. In many instances, contrast visualization is of confirmatory value only. In at least one-third of the cases in this series there existed reasonable clinical doubt and inadequate roentgen evidence of syphilitic aortitis. Aortas appearing unremarkable on conventional chest roentgenograms have repeatedly been shown to be dilated by angiocardiography. Contrast aortic visualiza-

tion represents the most practical and accurate diagnostic technique for the early recognition of syphilitic aortitis.

CONCLUSIONS

1. Angiocardiography greatly facilitates the early diagnosis of syphilitic aortitis; with this procedure, a diagnosis can often be made in the absence of conclusive clinical or roentgen evidence.

2. The angiocardiographic signs of syphilitic aortitis include aortic dilatation (above 38 mm., mid-ascending aorta), irregularity of lumen, calcification of ascending aorta, aortic tortuosity, variations in aortic wall thickness, and the presence of aneurysm.

3. Dilatation, the cardinal angiocardiographic sign of syphilitic aortitis may also be caused by hypertension, aortic valvular insufficiency of non-syphilitic etiology, or coarctation of the aorta; it is not pathognomonic of syphilis of the aorta. Aortic dilatation may be absent in early cases of syphilitic aortitis. Uncomplicated arteriosclerosis apparently does not cause aortic dilatation beyond the upper limit of 38 mm.

4. By means of angiocardiography, the diagnosis of syphilitic aortitis may be made sooner and put on a sounder anatomic basis, thus facilitating the earlier, more adequate treatment occasioned by the cardiovascular complications of syphilis.

Department of Radiology
The New York Hospital
525 East 68th St.
New York 21, N. Y.

REFERENCES

1. MOORE, J. E. *The Modern Treatment of Syphilis*. Charles C Thomas, Springfield, Illinois, 1944, p. 280.
2. WEBSTER, B., and READER, G. G. Effect of anti-syphilitic treatment on the microscopic appearance of syphilitic aortitis. *Am. J. Syph., Gonorr. & Ven. Dis.*, 1948, 32, 19.
3. THORNER, M. C., and CARTER, R. A. Roentgenologic diagnosis of syphilitic cardiovascular disease. *Am. Practitioner*, 1948, 2, 301-305.
4. SUSSMAN, M. L. Roentgen examination of the aorta and pulmonary artery. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 42, 75-84.

5. DOTTER, C. T., and STEINBERG, I. Angiocardiographic measurement of the normal great vessels. *Radiology*, 1949, 52, 353-358.
6. ROBB, G. P., and STEINBERG, I. Visualization of the chambers of the heart, the pulmonary circulation, and the great blood vessels in man; practical method. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 1-17.
7. JACKMAN, J., and LUBERT, M. Significance of calcification in the ascending aorta as observed roentgenologically. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 53, 432-438.

DISCUSSION

DR. MARCY L. SUSSMAN, New York, N. Y. Dr. Dotter and his associates have made a really notable contribution to the study of syphilitic aortitis. They pointed out that in the absence of aneurysm and aortic insufficiency, the diagnosis is almost entirely a roentgenologic one. The history or serologic evidence of lues is the occasion for the roentgenogram being taken or confirms an incidental roentgen finding.

Although some workers have felt that aortic measurements from conventional films are of value in determining dilatation, others, including myself, feel that they are unreliable in early disease when they must be used as the deciding factor. In making this statement, I do not mean to detract from their use as a guide on the road to diagnosis. If we assume that the early treatment of syphilitic aortitis is desirable and important, Dr. Dotter's report concerning the precise appearance of the aorta is obviously worthy of note.

Dr. Dotter has told us that dilatation is the most significant angiocardigraphic evidence of luetic aortitis. He reports that in 51 of his cases, the ascending aorta measured between 37 and 70 mm. while no normal measured more than 38 mm. We are in the midst of accumulating similar data but since I did not know precisely at what points Dr. Dotter made his measurements nor what corrections he made for the position of tube and patient to film, I am not in the position to critically evaluate this figure. We

can anticipate, however, that in common with other statistical experience, when a larger series is accumulated, apparently normal individuals will be found in whom this measurement is exceeded.

This will not invalidate the test since, in any case, it is folly to rely on a single finding. Furthermore, as Dr. Dotter points out, there are other causes of dilatation. More important, however, are those aortas whose measurements are less than 38 mm. which nevertheless have dilated from a small normal. On a purely statistical basis, we would expect a number of these. By coincidence, if you saw two of the slides I showed yesterday, they illustrate these points. In the typical luetic aneurysm that I showed, the ascending aorta measured 36 mm. The dissecting aneurysm, which as you know is practically never on a luetic basis, had an ascending aorta measuring 44 mm. but that patient had hypertension.

It seems to me that irregularity in the caliber of the aorta when affected by lues is of paramount importance. We pointed this out some time ago when we found the sign of great value in cases of aortic aneurysm where the aneurysm did not fill with diodrast. Here the diagnosis of aneurysm could still be made when the remainder of the aorta showed an irregularity in caliber.

However, in this connection, a word of warning is in order. We are encountering an increasing number of distorted aortas with uneven constrictions and dilatations which we presume to be congenital in origin. We call the condition atypical coarctation because there are no resulting disturbances in circulatory dynamics. These peculiar aortas are found not infrequently in association with congenital aortic stenosis, subclavian and carotid stenosis, tetralogy of Fallot and other congenital anomalies, but sometimes no other abnormality has been detected.

Therefore, one cannot assume that luetic aortitis is present simply because there is an uneven lumen. Once again, I congratulate Dr. Dotter and his co-workers on doing well a job that needed badly to be done.



INTRAVENOUS UROGRAPHY IN THE STUDY OF VESICAL NECK OBSTRUCTIONS*

By WILLIAM J. ENGEL, M.D.
CLEVELAND, OHIO

THERE are certain essential facts which should be known about patients with vesical neck obstruction in order to facilitate proper treatment and to increase the safety of operation. In addition to a careful general examination and routine laboratory studies, which all patients should have, a detailed appraisal of the status of the urinary tract is imperative. This should include: a determination of renal function and the condition of the upper urinary tract; detailed knowledge of the nature of the obstruction and the size and type of prostatic enlargement, as well as the presence of possible associated urinary tract disease, which may complicate the management. With intravenous urography we have a means of obtaining this information by a single examination, and this should be routine in all cases. Its value will be readily appreciated if we recall that it replaces less accurate renal function tests, and in most cases eliminates the need for cystoscopy and retrograde pyelograms; possibly urethrograms and cystograms as well. This is important inasmuch as some of these procedures are attended with definite risk, not to mention the discomfort they may provoke.

We have adopted the following routine in doing intravenous urograms which we particularly recommend for these cases. A preliminary blood urea estimation is performed, as we have found that if the urea is 70 mg. per cent or above, the urogram is usually unsatisfactory. The patient is preferably prepared the evening before by administering castor oil, and fluids are limited the following morning preceding the examination. A plain film of the abdomen is made followed by the intravenous administration of diodrast.

Before injecting the diodrast it is a wise precaution to inquire into any history of allergy or drug sensitivity in the patient, particularly to iodine. In doubtful cases one should perform a preliminary test by intradermal injection, or by placing 1 or 2 cc. of diodrast beneath the tongue. Although fatalities due to severe allergic reaction have been reported following the intravenous administration of diodrast, we have observed no serious reaction in the course of many thousand injections.

Following the injection of the dye 14 by 17 inch films of the entire urinary tract are made at intervals of five minutes, fifteen minutes, thirty minutes, and sixty minutes. At the time of the thirty minute film an additional 10 by 12 inch film is made to include the lower ureters, bladder, prostate, and urethra. This affords a more detailed cystogram. Following the last film, if desired, a residual urine film may be obtained after the patient has voided, thereby making it possible to ascertain the amount of urine remaining in the bladder.

The films are viewed as a series and their interpretation will be discussed under four headings: (1) renal function, (2) determination of the type of prostate, (3) the upper urinary tract changes and their significance, and (4) associated urinary tract lesions.

RENAL FUNCTION

Recent studies in renal physiology have shown that the ability of the kidneys to excrete diodrast (the diodrast clearance) is one of the most reliable tests of total renal function because this substance is cleared both by filtration and tubular excretion. The intravenous urogram may be considered as a visual means of estimating diodrast excretion. The films afford a frac-

* From the Cleveland Clinic and the Frank E. Bunts Educational Institute. Presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

tional function test which constitutes an additional refinement.

Findley¹ and his co-workers studied the iodine excretion in the urine following the intravenous injection of diodrast and compared it with the urea clearance test. They found that the normal kidneys excrete 40 to 50 per cent (average 45 per cent) of the diodrast in the first thirty minutes following injection and reductions in the rate of iodine excretion are roughly proportional to the variations in the urea clearance. This affords us a sound basis for the spacing of the films and serves as a guide in estimating the renal function when studying the films.

Other studies have been carried out to compare the urogram with other renal function tests. Kornblum and Fetter² found 70 per cent agreement with the fractional phenolsulfonphthalein test, and Braasch and Emmett³ found 78 per cent agreement with the indigo carmine test.

While the intravenous pyelogram may lack the accuracy of the more refined renal function tests, one obtains a gross estimate of renal function which is entirely adequate to evaluate the surgical risk and direct the preoperative management. Only in those cases in which inadequate visualization renders functional estimation impossible have we found it necessary to resort to other renal function tests.

What criteria should be employed in evaluating the functional status of the kidneys from the interpretation of the films? With normal renal function there will be a prompt thrust excretion resulting in a good nephrogram and distinct visualization of the renal pelves in the five minute film. Maximum visualization of the upper urinary passages will occur in the fifteen and thirty minute films with only traces of dye remaining in the one hour plate. Additional evidence of adequate renal function is to be found in the increasing amount and intensity of dye in the bladder which reaches its peak on the one hour film.

At the other extreme let us consider the patient who, after the injection of diodrast, shows no trace of the dye throughout the urogram series with, perhaps, only traces in

the bladder after one hour. This is indicative of definitely impaired renal function, and such a patient requires careful pre-operative preparation.

Between these extremes numerous gradations may be observed. There are cases with delayed excretion but with satisfactory visualization of the upper urinary tract in the fifteen or thirty minute films which present no evidence of urostasis or dilatation and minimal retention of dye in the renal pelves in the one hour film. From the surgical point of view this indicates adequate renal function, and if the blood chemistry is within normal limits one may proceed with operation without the delay of prolonged drainage.

If, however, there is delayed function with maximum visualization on the thirty minute or one hour film which reveals dilated, tortuous ureters and hydronephrosis, impaired renal function is indicated and one must institute prolonged drainage until renal function is restored to a more normal level (Fig. 10).

Several observations are of interest. In general, the degree of renal damage is dependent upon the duration and type of obstruction. In this connection it is paradoxical that the longer the duration of symptoms and the larger the residual urine, the smaller the prostate. Thus the large, palpable, chronically overdistended bladder often occurs as the result of a fibrous contracture of the vesical neck or a small subcervical middle lobe. On the other hand, large intravesical prostates and subvesical hypertrophies, presumably of long standing, may present little if any renal damage from back pressure. Residual urine per se is no index of renal damage, for it is not uncommon to see patients with residual urines of 500 cc. or more with an essentially normal upper urinary tract.

Not all cases with diminished renal function can be attributed to vesical neck obstruction. With patients in the prostatic age group there will be a certain number with arteriosclerotic kidney disease and other renal lesions resulting in impaired function. Additional renal function studies

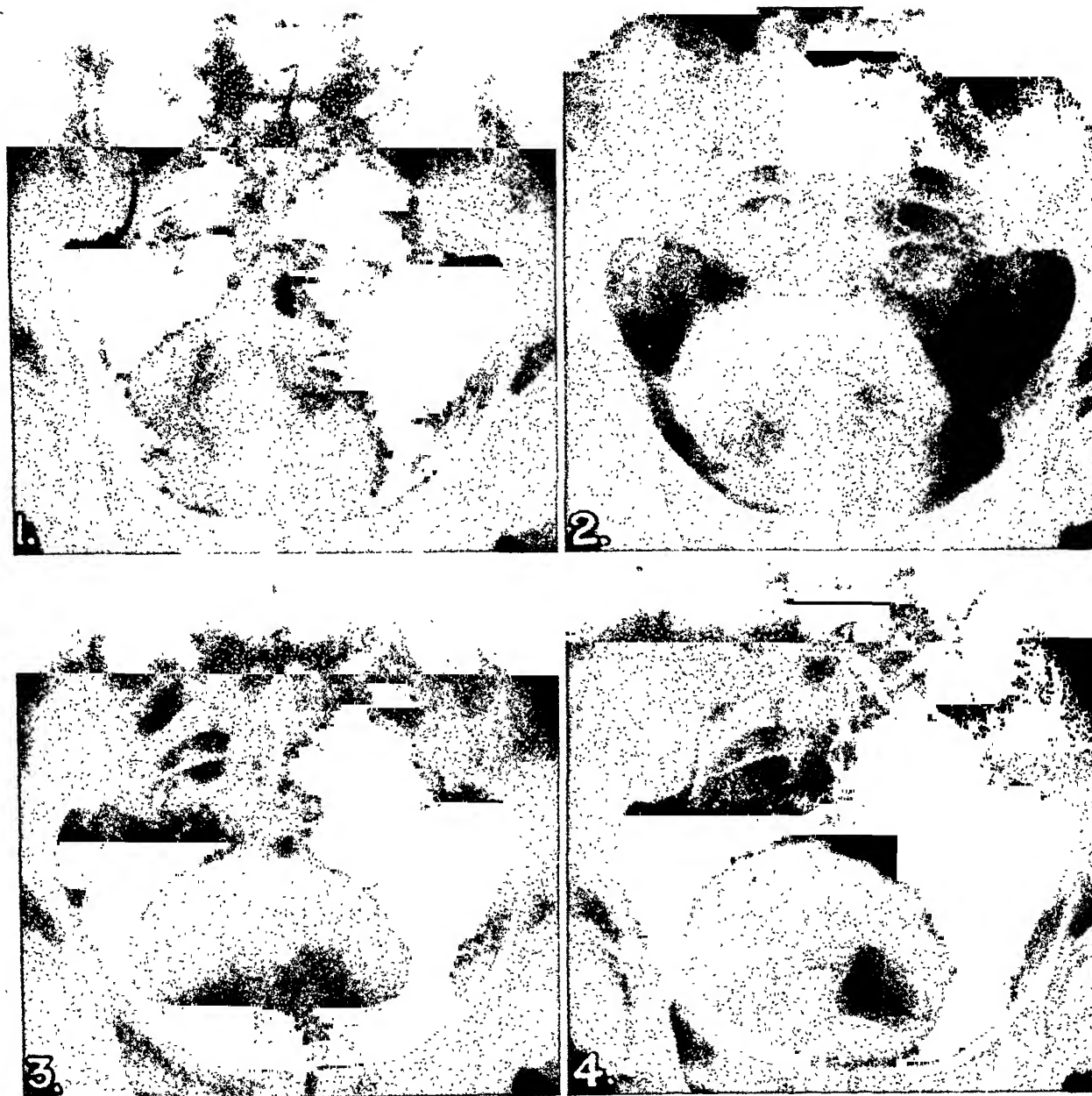


FIG. 1. Serial cystograms obtained by intravenous urography. No. 1 urogram five minutes; No. 2, fifteen minutes; No. 3, thirty minutes; No. 4, sixty minutes following diodrast injection. As bladder fills the prostatic shadow becomes obscured.

may be indicated in such cases, but the urogram will have served an important role in identifying those due to obstruction.

TYPE OF PROSTATE

Vesical neck obstructions fall into four types: (1) contractures and fibrotic median bars; (2) intravesical enlargement; (3) sub-vesical or intraurethral enlargement, and (4) carcinomas. Types 2 and 3 may exist in combination.

The serial cystogram affords valuable assistance in the differentiation of the vari-

ous types. The urogram is started with the bladder empty and as the bladder fills visualization of deformities of the bladder base will be well demonstrated (Fig. 1). The roentgenological findings are dependent upon the type of obstruction and its resulting effect upon the bladder and upper urinary tract.

(1) Fibrotic contracture or median bar is a slow, insidious obstructing lesion of the vesical neck. The increased emptying effort of the bladder results in hypertrophy of the muscle, particularly the trigone. In this



FIG. 2. No. 2 urogram illustrating crescentic shadow produced by hypertrophy of trigone.

process there is often formed a deep depression behind the interureteric ridge, the so-called bas-fond, and in long-standing cases there is extensive trabeculation of the bladder with multiple sacculations, or diverticula. Because there is no enlargement of the prostate the cystogram shadow will present no deformity of the bladder base. The hypertrophy of the trigone may be recognized by a transverse crescentic shadow whose concavity is toward the dome of the bladder (Fig. 2). In some cases the deep bas-fond will produce a circular or oval shadow of increased density lying within the cystogram (Fig. 3). These changes are best demonstrated in the fifteen or thirty minute film and may be obliterated with the bladder filled in the one hour film. The one hour film, however, best demonstrates the irregularities produced by sacculations and diverticula. In my experience, upper urinary tract changes come late with vesi-

cal neck contractures and are usually associated with decompensation of the bladder and large residual urine.

(2) Intravesical Enlargement. In 1922 Tandler and Zuckerkandl⁴ studied the anatomy of benign prostatic hypertrophy and distinguished two types of enlargement both of which arise from the region of the prostatic urethra lying between the verumontanum and the vesical sphincter. In one, the prostate grows up through the bladder orifice and acquires an intravesical position. It is covered only by mucous membrane and the sphincter through which it grows often compresses it into a pedunculated lobe (Fig. 4). As it extends anteriorly it may assume a horseshoe shape or a variety of other shapes may result from different arrangements of adenomas (Fig. 5). From the standpoint of urographic interpretation, however, all have in common the intravesical position and some degree of narrowing of the base. Since they are able to expand within the cavity of the bladder, upper urinary tract changes are



FIG. 3. No. 3 urogram from patient with vesical neck contracture. Oval shadow within bladder shadow is produced by deep depression above and behind the vesical trigone.

not seen in the uncomplicated intravesical enlargement. I have on one occasion removed an intravesical hypertrophy weighing 330 gm. in which the intravenous urogram revealed a normal upper urinary tract.

The intravesical enlargements are thus recognized by the filling defect projecting into the bladder cavity from the floor of the bladder. This is characterized by the fact that the base is narrower than the main body of the projecting mass. This narrowing is due to the constricting effect of the internal vesical sphincter.

(3) Subvesical Enlargement. In the second type of prostatic enlargement described by Tandler and Zuckerkandl the whole tumor mass is subvesical. It is covered above by the bladder muscle and mucosa and the entire floor of the bladder is elevated (Fig. 6). The vesical orifice and sphincter, however, remain intact. Since expansion below is rendered impossible by

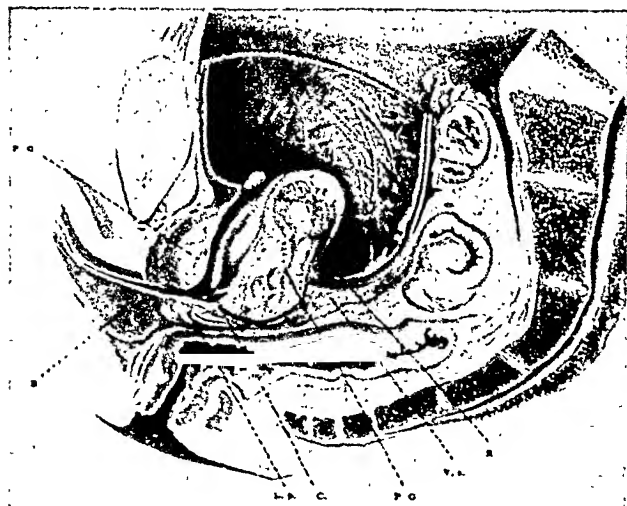


FIG. 4. Drawing showing intravesical projection of enlarged prostate. (After Tandler and Zuckerkandl.⁴ Taken from *Acta radiol. supp.* 28, 1935.)

unyielding ligaments and fascia, upward expansion progresses with resulting lengthening of the prostatic urethra and upward displacement of the trigone of the bladder.

In the urograms this produces two characteristic changes. The elevated bladder

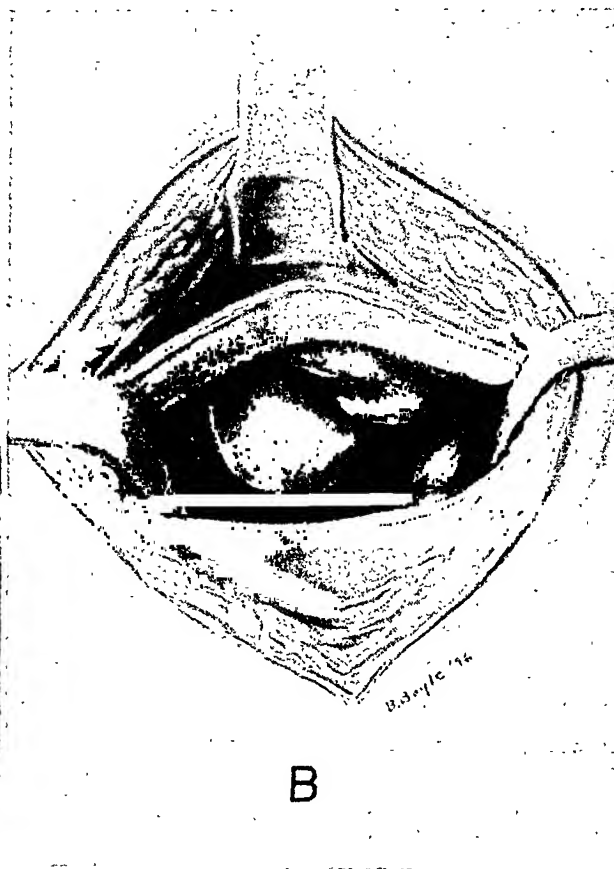


FIG. 5. (A) No. 3 urogram showing irregular intravesical prostatic shadow. Observe that the base is more narrow than the intravesical portion. (B) Drawing made at operation in same case showing multilobular intravesical prostatic enlargement.

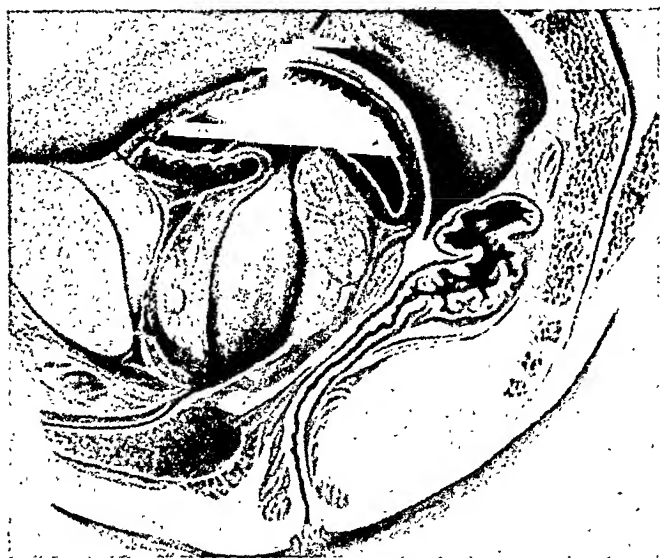


FIG. 6. Drawing showing subvesical enlargement of prostate. The entire bladder base is displaced upward. (After Tandler and Zuckerkandl.⁴ Taken from *Acta radiol.*, supp. 28, 1935.)

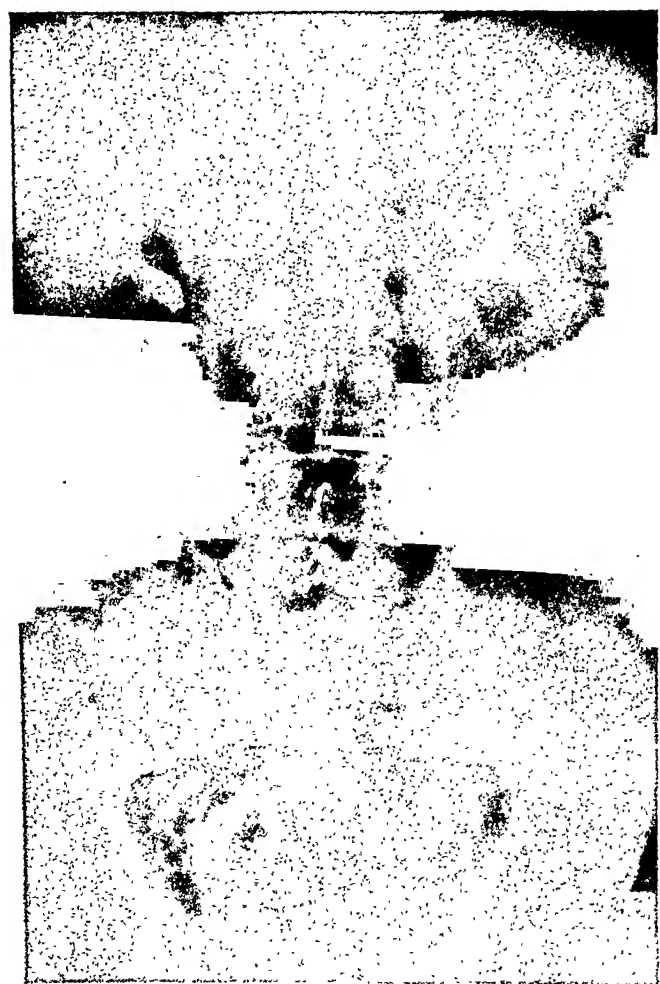


FIG. 7. No. 3 urogram showing broad, dome-shaped prostatic shadow typical of subvesical hypertrophy. Note also "fish-hook" deformity of lower left ureter.

base manifests itself as a broad dome-like deformity whose base is its broadest point (Fig. 7). This is often best visualized in the early films of the cystogram series and may be obscured as the bladder fills around it (see Fig. 1). The second change is the result



FIG. 8. No. 3 urogram illustrating bilateral "fish-hook" deformity of lower ureters. In this case early dilatation of the ureters and renal pelvis is also demonstrated.

of the upward displacement of the trigone and ureteral orifices which produces angulation of the lower ureters of varying degree. In extreme cases a reverse curve is produced which, because of its shape, has been termed "fish hooking" (Fig. 7 and 8). The significance of this will receive later comment. Squire and Kretschmer⁵ called attention to this ureteral deformity in prostatic hypertrophy but did not comment upon the mechanism of its production.

Combinations of intravesical and subvesical enlargement often occur in the same patient which may give rise to some difficulty of interpretation. Application of the broad principles enunciated above will usually lead to a correct assessment if one recalls that when the two coexist the intravesical mass "sits on top" of the subvesical enlargement. However, in some cases, the roentgenological findings may require the aid of the examining finger of the urologist or perhaps cystoscopic investigation to supply the needed information.

(4) Carcinoma of the Prostate. In the absence of bone metastases there are no consistent urographic findings which supply incontrovertible evidence of the presence of prostatic carcinoma. Suspicion should be aroused, however, if the prostatic shadow is irregular in outline or if distinctly irregular nodules are visible at the vesical neck. Also the presence of unilateral ureteral obstruction is suggestive evidence (Fig. 9). This is produced by unilateral extension of the neoplasm with invasion of the tissues surrounding the lower ureter. One cannot, however, expect much roentgenological assistance in the early diagnosis of carcinoma of the prostate. The trained examining finger is far more reliable.

STATUS OF THE UPPER URINARY TRACT

From the point of view of the prostatic surgeon, this is one of the most important considerations, and it is best determined by intravenous urography.

It should be pointed out that blood chemistry studies alone cannot be depended upon to give a clear picture of the status of the upper urinary tract. We have encountered patients with a normal blood urea in whom the intravenous urogram revealed pronounced bilateral hydronephrosis and hydronephrosis. Thus, the urogram is the more reliable guide to the status of the upper urinary tract.

Vesical neck obstruction is a slow insidious process which begins as pathological physiology and progresses to anatomical change with later renal functional impair-

ment. At first the obstruction is overcome by increased contraction of bladder muscle which leads to hypertrophy of muscle and later trabeculation. Eventually, when the bladder is no longer able to empty itself, residual urine accumulates and the bladder may be said to be decompensated. There



FIG. 9. No. 2 urogram showing dilatation of lower right ureter in a patient with carcinoma of prostate. Left ureter is normal.

comes a time when the intravesical pressure approaches and then exceeds the ureteral secretory pressure and when this stage is reached, ureteral dilatation begins and gradually extends up to the renal pelves and collecting tubules, at which time impaired renal function results. This train of events is particularly applicable to chronic incomplete obstructions such as fibrous contractions and small obstructive intravesical lobes. In the subvesical hypertrophies an added factor of ureteral compression and

angulation hastens the process of upper urinary tract dilatation.

Ureteral angulation should therefore be regarded with some concern. We have observed several patients who upon first examination presented the picture of moderate prostatic intrusion with early angulation of the lower ureters but with normal



FIG. 10. No. 4 urogram showing advanced bilateral hydronephrosis with dilated and tortuous ureters. Careful preoperative drainage is essential in such cases.

ureters and renal pelvises. Re-examination of the same patients who returned after several years without treatment showed extensive bilateral hydroureter and hydronephrosis with impaired renal function. Ureteral angulation, therefore, should be regarded as an indication for the operative correction of prostatic obstruction if further upper urinary tract damage is to be avoided.

Bilateral upper urinary tract dilatation

with delayed and impaired renal function is of significance to the urologist as an imperative indication for careful preoperative drainage (Fig. 10). Following an appropriate period of drainage, a recheck urogram will show striking recovery of renal function and a reduction in upper urinary tract dilatation. Only then does the patient become a safe surgical risk.

Kretschmer and Squire⁶ recently studied the incidence of hydronephrosis in prostatic obstruction; 44.4 per cent of patients examined between 1933 and 1937 showed some degree of upper urinary tract dilatation while only 33.4 per cent of those observed between 1945 and 1947 were so affected. This difference was attributed to patients having sought earlier relief from obstructive symptoms. The average duration of symptoms was 60.5 months in the first group but only 43 months in the latter. Our experience coincides with this and today extensive bilateral hydronephrosis and ureterectasis is infrequently encountered.

ASSOCIATED URINARY TRACT DISEASE

Incidental but valuable information gathered from the routine use of urography for prostatic obstructions concerns the disclosure of additional and often unsuspected disease in the urinary tract. The plain film may reveal calculi in the kidneys, bladder or prostate, and in one instance a calculus impacted in the prostatic urethra had produced obstructive symptoms indistinguishable from bladder neck obstruction. By means of the urogram we have been able to distinguish renal tumors and solitary cysts. In one patient a congenital solitary kidney was recognized, while another showed renal tuberculosis. The cystogram shadow will indicate the presence of bladder diverticula and sacculations, and we have recognized several bladder tumors by the deformity produced in the cystogram series.

While this additional information may not always influence the treatment of the case, the incidental findings may prove to be the patient's most serious problem. In all instances this knowledge contributes to

intelligent diagnosis and consequent treatment.

SUMMARY AND CONCLUSIONS

Attention is drawn to the value of intravenous urography in the study of patients with obstruction of the urinary bladder neck and its routine use is recommended.

By means of this single examination we may determine (1) renal function, (2) the type of obstruction and the degree of enlargement of the prostate, (3) the status of the upper urinary tract and (4) associated urinary tract disease.

From this information the urologist is guided in (1) the preoperative treatment of the patient, (2) selection of operation and (3) evaluation of the risk. This knowledge, properly applied, increases the safety of prostatic surgery.*

Cleveland Clinic
Cleveland 6, Ohio

REFERENCES

1. FINDLEY, T., EDWARDS, J. C., CLINTON, E., and WHITE, H. L. Intravenous urography; test of renal function. *J. Urol.*, 1942, 48, 119-125.
2. KORNBLUM, K., and FETTER, T. R. Value of excretory urography in interpretation of renal function. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 770-786.
3. BRAASCH, W. F., and EMMETT, J. L. Excretory urography as test of renal function. *J. Urol.*, 1936, 35, 630-642.
4. TANDLER and ZUCKERKANDL. Cited by KNUTSON, F. Urethrography. Röntgen examination of male urethra and prostate after injection of contrast material into urethra. *Acta radiol.*, supp. 28, 1935, pp. 1-150.
5. SQUIRE, F. H., and KRETSCHMER, H. L. Study of ureters in bladder neck obstructions. *Radiology*, 1946, 46, 32-35.
6. *Idem*. Incidence and extent of hydronephrosis in prostatic obstruction. *J. Urol.*, 1948, 60, 1-6.

* For discussion, see page 673.



DEFORMITIES OF THE BLADDER SECONDARY TO URETERAL STONE*

By BERNARD HALL, M.D., and HAROLD O. PETERSON, M.D.

Miller Hospital

ST. PAUL, MINNESOTA

EDEMA and swelling about the ureteral orifice has long been recognized by the cystoscopist as a secondary sign of a calculus located in the intramural portion of the ureter. Actual prolapse of the mucous membrane of the ureter may occur as well. These changes are completely described and illustrated in many of the standard works on urology. Lowsley and Kirwin³ state that cystoscopic examination will usually give definite evidence of the presence of a stone at or near the ureteral orifice. There will be swelling and edema which is sometimes accompanied by hemorrhage from the bladder mucosa. MacAlpine⁵ describes the edema as first involving the immediate vicinity of the ureteral orifice, and later spreading to the interureteric bar, and the region of the trigone. In severe cases the whole trigone may be involved with the production of bullous edema.

Although these findings are well known to the cystoscopist, there has been very little attempt to correlate this observation with changes in the roentgenogram. Polgar⁷ in 1936 reported one case in which he observed a filling defect in the region of the left ureteral opening secondary to a stone in the intramural portion of the ureter. He felt that in the plain roentgenograms of his case the urine alone was sufficient contrast material to outline the area of edema and swelling. However, he was able to demonstrate it better by means of cystography using a fairly dilute contrast material. Herskovits,² in 1938, following Polgar's description reported 2 cases with defects in the bladder due to the swelling about a calculus in the intramural portion of the ureter. These were observed in the course of excretory urography. Edling¹ in his article on the "Interureteric Fold in the Roentgenogram" mentioned the changes

occurring in the interureteric region of the bladder as a result of calculi in the distal end of the ureter. No reference to this finding in the English journals was found after a fairly careful search. Kerr and Gillies' text on "The Urinary Tract," page 176, refers to Edling's paper but states they have so far found it of no value.

In the past seven years (1941-1948) at the Charles T. Miller Hospital, 106 patients in whom a diagnosis of ureteral stone has been established have had intravenous urograms. In 26 of the 106 cases, the stone was located in the intramural portion of the ureter. In 19 of these, deformities were present in the bladder shadow in the region of the ureteral orifice, undoubtedly due to edema and swelling caused by the stone. These were classified into three groups depending upon the degree of deformity of the bladder shadow. Four were classified as showing a marked deformity, 6 as moderate, and 9 as a slight but definitely recognizable deformity. Cystoscopic examination was done on 12 of the patients and in all of these the finding of edema and swelling of the region of the ureteral opening was confirmed.

The filling defects in the bladder are of two general types depending on the extent of the edema. First, those in which the swelling is confined to the region of the ureteral orifice and the interureteric ridge. In these cases, the filling defect is within the bladder shadow, in the anteroposterior view. There may be asymmetry of the interureteric ridge (Fig. 1 and 2). When the bladder is completely filled, as at the completion of urography or by retrograde cystography, the deformity is often less prominent as it becomes obscured by the dense may make it impossible to obtain clear outlines of the antrum. This statement applies

* Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

contrast medium. Polgar⁷ states that in this type, the deformity in the bladder contour can be better seen in the oblique projection. In this way a tangential view is obtained demonstrating the projection of the swollen ureteral orifice region into the bladder. In the second type of deformity, the edema and swelling is more pronounced and extends downward toward the trigone, or upward toward the dome of the bladder, or both, and results in a marked irregularity of the superior, inferior, or lateral portions of the bladder outline (Fig. 3, 4 and 5).

CLINICAL SIGNIFICANCE

In our experience, if the ureteral calculus is located in the intramural portion of the ureter, a filling defect in the bladder can be recognized in a large number of the cases (19 of 26 cases) and is therefore a common secondary sign of ureteral calculus. Calculi in this location are often tiny and difficult to diagnose, and any aid in their recogni-



FIG. 1. Asymmetry of the interureteric ridge with marked enlargement of the right side of the ridge extending to the lateral bladder wall (black arrows). Reddening and well marked edema about the right ureteral orifice was reported at cystoscopic examination. White arrow points to small stone.



FIG. 2. During the course of the intravenous urogram, an area of decreased density within the bladder shadow is visible (arrows). This surrounds the shadow of the stone in the ureter. At cystoscopy a pyramidal area of edema was present about the ureteral orifice.

tion is of value. This difficulty in diagnosis was emphasized by Peterson and Holmes⁶ in 1937. They found, in reviewing 100 cases of ureteral calculi, that of 17 calculi not diagnosed on initial interpretations, 16 were located in or close to the intramural portion of the ureter.

If the calculus is non-opaque, its location and presence are difficult to establish roentgenographically. In these cases of non-opaque stones which are located in the intramural portion of the ureter, the filling defects of the bladder may be helpful as an aid in diagnosis and localization.

The filling defect within the bladder and the changes in its contour are often quite marked, and may simulate the defects secondary to bladder carcinoma. One of our cases (Fig. 4) demonstrates this very well. The entire left side of the bladder shadow is obliterated and the margin of the bladder shadow on the left is irregular. On the initial examination this defect was considered to be due to a carcinoma of the



FIG. 3. There is a filling defect on the right side of the bladder with asymmetrical enlargement of the interureteric ridge on the right. A calculus is faintly visible in the center of the defect (white arrow). At cystoscopy a marked edema of the right side of the bladder was visualized.



FIG. 4. There is marked irregularity and deformity of the left side of the bladder shadow. A calculus is visible in the lower left ureter overlying the coc-

cyx. The small calculus overlying the coccyx was interpreted as a calcification within a bladder tumor. Its midline location is probably due to displacement caused by the edema. There was swelling and edema in the region of the ureteral orifice cystoscopically and no evidence indicating a neoplasm. The stone could not be re-



FIG. 5. Deformity and irregularity of the bladder is present on the right. A calculus is visible in the intramural ureter (arrow). Note the obstruction of the right ureter with slight hydronephrosis and hydroureter. At cystoscopy marked swelling and edema of the right interureteric ridge was reported, and a smooth black calculus was visualized within the right ureteral orifice.

moved at this time, but was passed spontaneously two weeks later with complete recovery of all signs and symptoms.

MacAlpine⁵ has reported that by cystoscopic examination the region of the ureteral opening returns to normal in about one week after the passage of the stone. If this is true, the edema of the mucous membrane which remains for a time after pas-

cyx (arrow). The stone was located at cystoscopy but could not be removed. It passed spontaneously later. There was no tumor in the bladder.

sage of the calculus may be of importance in some of those patients with a fairly typical history of ureteral colic in whom the pain has subsided before the intravenous urogram could be done. The stone may have been passed and there may be no evidence of obstruction of the ureter, but the urogram may still show the typical defect of the bladder due to an intramural calculus. We have had occasion to interpret this finding as due to an intramural ureteral calculus which has recently passed. This has been helpful in establishing the cause of the abdominal pain.

SUMMARY

1. Calculi in the intramural portion of the ureter may produce sufficient edema and swelling of the bladder mucosa to be recognized as a filling defect in the bladder during intravenous urography.

2. Recognizable defects were present in 19 out of 26 cases of intramural calculus and thus are a common secondary sign of ureteral calculus in this location.

3. The more marked defects in the bladder due to a calculus may simulate the deformity caused by a carcinoma of the bladder.

4. Bladder deformity may be demonstrated for a short time following passage of the stone, which can be helpful in establishing a diagnosis in those patients who have passed the stone before the roentgen examination is done.

Miller Hospital
St. Paul, Minn.

REFERENCES

1. EDLING, N. P. G. Der Interureterwulst im Röntgenbild. *Acta radiol.*, 1941, 22, 573-580.
2. HERSKOVITS, E. Zur Kasuistik des Füllungsdefektsymptoms der Harnblase bei Steinen im Intramuralen Teil des Ureters. *Röntgenpraxis*, 1938, 10, 461-463.
3. KERR, H. D., and GILLIES, C. L. The Urinary Tract: A Year Book of Roentgen Diagnosis. Year Book Publishers, Chicago, 1944, p. 176.
4. LOWSLEY, O. S., and KIRWIN, T. J. Clinical Urology. Vol. 2. Williams & Wilkins Co., Baltimore, 1940, p. 1192.
5. MACALPINE, J. B. Cystoscopy and Urography.

William Wood & Co., New York, p. 302.

6. PETERSON, H. O., and HOLMES, G. W. Roentgen analysis of 100 cases of ureteral stone. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 479-483.
7. POLGAR, F. Röntgendarstellung des intramuralen Ureterabschnittes. *Röntgenpraxis*, 1936, 8, 708-709.

DISCUSSION OF PAPERS BY DRS. ENGEL AND PETERSON AND HALL

DR. VINCENT J. O'CONOR, Chicago, Ill. Drs. Peterson and Hall have made an interesting and instructive contribution calling attention to the extreme deformity which often occurs on that side of the bladder wall in which an intramural calculus is impacted. The deformity seen in the cystogram is often much greater than the cystoscopic appearance would suggest. A note of warning must be sounded in regard to the interpretation of these deformities when they persist after the passage of a stone. Primary tumor of the lower end of the ureter may be confused with calculus. Since lime salt encrustation can and does occur on papillary tumors this differentiation may be troublesome.

We have seen 3 patients with tumors in lower end of ureter where particles of stone have passed but the edema and deformity persisted and fortunately we insisted upon a complete nephro-ureterectomy and cured the patient at an early stage of the disease.

(Slides were shown at this point.)

Dr. Engel is to be congratulated on emphasizing the great advantages which result from routine excretory urographic studies in patients with prostatic hypertrophy and other types of vesical neck obstruction. Wherever it is economically possible we make this a routine. Our interest is centered upon ruling out obstructive uropathy in the upper tract, stone, tumor and anomaly.

Since many men with enlarged prostates present themselves originally with a bladder full of clots we must always be sure that the patient is not bleeding from a renal or ureteral tumor or more commonly a bladder tumor.

Excretion urography is most important but is only an important part of a complete urological examination. Blood chemistry studies, urinary intake and output, renal function tests and cystoscopic study are equally important in what they may disclose of the patient's condition.

ROENTGEN DIAGNOSIS OF CHOLESTEATOMA OF THE MIDDLE EAR*†

By JULES G. WALTNER, M.D.

NEW YORK, NEW YORK

CHOLESTEATOMA is an epidermoid inclusion cyst which develops in the mastoid as a result of the extension of squamous epithelium into the middle ear through a perforation in the drum. It is associated with chronic purulent otitis media and may cause serious complications at practically any stage of the suppurative process. These complications include temporal lobe and cerebellar abscesses, thrombophlebitis of the sigmoid and lateral sinuses, purulent meningitis, purulent labyrinthitis and facial paralysis. Every cholesteatoma, due to the nature of its growth and its destruction of the surrounding structures, is a potentially dangerous disease. Chemotherapy and antibiotics have no effect upon its growth. Once a cholesteatoma is present, surgical procedures such as radical or modified radical operations should be considered. An epitympanic marginal perforation of the drum seems to be an almost absolute prerequisite in establishing the diagnosis of cholesteatoma, but the presence of such a perforation does not necessarily mean the presence of cholesteatoma. This seems to be definitely proved by accumulated histopathological data. A positive fistula test is one of the most important clinical signs of cholesteatoma if accompanied by the presence of an epitympanic marginal perforation of the drum or a bony defect of the lateral wall of the attic. Labyrinthine vertigo and deep-seated headaches are significant symptoms.

Although the above clinical signs should be paramount factors in the diagnosis of cholesteatoma of the middle ear, roentgen diagnosis should be attempted in every instance for three reasons: (1) to confirm

the clinical diagnosis, (2) to detect early cases still lacking clinical symptoms, (3) to determine the extent of the cyst.

The difficulties of roentgen diagnosis of cholesteatoma of the middle ear are frequently observed. Areas of decreased density suggestive of cholesteatomas in roentgenograms many times fail to materialize as epidermal cysts at operation. Even more frequently, a cholesteatoma is discovered at operation in spite of negative roentgen findings. The number of cases belonging to the undiagnosed cholesteatoma group is larger than is apparent from statistics^{3,6} because operation is too many times not performed because of inconclusive roentgen findings. Investigation of these diagnostic difficulties led to the present studies of the inherent limitations of roentgen diagnosis of cholesteatomata.

ANATOMY

It is natural that the first scope of these studies should concern itself with the establishment of the normal size of the mastoid antrum in the sclerotic bone. Entirely sclerotic temporal bones were used for measurements, because cholesteatomas almost invariably are found in non-pneumatized mastoids. Sixteen such specimens were studied in serial sections. None of them showed microscopic evidence of cholesteatoma. In three of the sixteen temporal bones there was an acute inflammation present in the middle ear. Chronic purulent otitis media with a central perforation of the drum was evident in one of the temporal bones. The width and the anteroposterior diameter of the mastoid antrum were measured under the microscope in every tenth consecutive section of

* From the Department of Otolaryngology, Columbia University College of Physicians and Surgeons, and the Presbyterian Hospital, New York.

† The study was assisted by the Hayden-Cockley Fund.

the bones which were serially cut in the horizontal direction. The height of the antrum was obtained by adding up the thickness of all the consecutive sections. In the four bones which were cut serially in the vertical direction only the height and the anteroposterior diameter could be measured. The width, the height and antero-

portions of the antrum was 4-5 mm. in some bones and 2-3 mm. in others. A most significant finding is the fact that the width of the antrum measured more than 6 mm. in a considerable number of consecutive sections in all bones studied in this series. The greatest diameter (width) was as much as 8-10 mm. in some bones, but these

TABLE I
MEASUREMENTS OF MASTOID ANTRUM IN SERIAL SECTIONS

Serial Number	Greatest Width of Antrum in mm.	Smallest Width of Antrum in mm.	Average Width Near Base of Antrum in mm.	Height of Antrum in mm.	Greatest Anteroposterior Diameter of Antrum	Smallest Anteroposterior Diameter of Antrum	Proportion of All Consecutive Sections in Which Width is Greater than 6 mm.	Extent of Height of Antrum Along Which Width is Greater than 6 mm.	Nature of Surrounding Bone	Middle Ear	Audiogram	Age	Section: V—vertical H—horizontal
1	10.5	2	3-4	10	6.5	3	1/2	5.5	Sclerotic	Normal	Normal	41	H
2	—	—	—	11	10	4	—	—	Sclerotic	Normal	Normal	41	H
3	11	3.5	3.5	6.2	7	2	4/5	5	Sclerotic	Normal	—	45	H
4	11.5	5	5	12	7	4	2/3	7.5	Sclerotic few cells	Acute purulent otitis media	—	45	H
5	9	—	7	—	—	—	—	—	Sclerotic	Acute purulent otitis media	—	47	H
6	8	6	6	8	6.5	4.5	1/2	3.5	Diploic	Acute purulent otitis media	—	47	H
7	9.5	3	5	9	9	3	1/3	3	Sclerotic	Normal	—	52	H
8	10.5	3.5	5	10	8	3.5	2/3	6.5	Diploic	Normal	—	52	H
9	10.5	7	7	9	8	4	3/4	7.5	Diploic	Normal	—	54	H
10	10	4	5	8.8	7	5	2/3	5.3	Sclerotic	Normal	—	54	H
11	9	5	5	11.5	8	4	1/4	3.3	Sclerotic	Normal	Good	55	H
12	9	4	5	5.5	5	2	1/2	2.8	Sclerotic	Normal	Normal	70	H
13	—	—	—	9	10	7	—	—	Diploic	Normal	—	35	V
14	—	—	—	4	—	—	—	—	Sclerotic	Chronic purulent otitis media	Normal	52	V
15	—	—	—	7	—	—	—	—	Sclerotic	Normal	—	65	V
16	—	—	—	7	—	—	—	—	Sclerotic	Normal	—	75	V

posterior diameter refer to the corresponding diameters with the antrum in occipital position (Table I).

Going upward from the base towards the roof of the antrum, the width showed considerable variation at different levels. Invariably the smallest figures were found close to the base. The width of the antrum grew gradually or abruptly at the level of the lateral semicircular canal. The difference between the narrowest and widest

figures were not found at all levels along the vertical axis of the antrum. Varying from one bone to the other one-third to four-fifths of all consecutive sections showed the mastoid antrum wider than 6 mm. A separate column of the table indicates what proportion of all consecutive sections measures more than 6 mm.

The width of the antrum in its inferior third was less than 6 mm. in all but two bones.

The vertical diameter (height) of the antrum proved to be greater than 10 mm. in three of the sixteen bones of this series. The height ranged from 4 mm. to 12 mm. in different temporal bones.

The anteroposterior diameter of the antrum showed equally great variations. It measured from 2 mm. to 10 mm. at various levels along the vertical axis. The variation in the anteroposterior diameter in the same antrum ranged from 2 mm. to 6 mm. As a rule the width of the antrum was larger than its anteroposterior diameter in each individual section. It was found that the thickness of the bony walls of the antrum was usually but not invariably in inverse relationship to the anteroposterior diameter of the same. The inner table which separates the antrum from the cerebellar fossa may be as thin as 0.75 mm. or may measure 4-6 mm. in thickness.

There was nothing characteristic about the shape of the mastoid antrum which would allow a comparison with pathological changes. Its form was somewhat irregular in most of the bones. In some it was ovoid, in others circular. In all bones, however, there was a progressive decrease in the width of the antrum going from the tegmen towards the base. It has a roughly conical shape with a blunt tip pointing downwards.

The bone which surrounded the antrum was mostly sclerotic. In a few instances diploic bone formed the wall in some places and occasionally a few very small cells containing thick wall were found adjacent to the antrum.

An attempt to reach conclusions regarding the standard size and shape of the attic proved to be fruitless. Variations in all three diameters, width, height and anteroposterior, were so prevalent that useful conclusions could not be made. The thickness of the lateral wall of the attic and tegmen tympani equally shows great variations adding to the difficulties of roentgen diagnosis of this cavity. Only extensive bone destruction in the attic can be interpreted as being pathological.

PATHOLOGY

Cholesteatoma may develop in the antrum, in the attic or may invade both of these cavities. On reviewing 50 consecutive radical mastoid operations at which cholesteatoma was found, the pathologic condition was localized to the mastoid antrum in 30, to the attic alone in 10, and to both antrum and attic in 10 cases. Some of the cholesteatomas seen at operation were small, others were very large occupying a considerable portion of the mastoid and petrous bones and extending through the posterior wall of the external auditory canal. Even a small cholesteatoma can, however, destroy the walls of a small antrum or attic and cause serious complications. This is especially true for the attic.

The height of the antrum measured only 4-7 mm. in four of the sixteen bones studied in serial sections. This would mean that in such bones, 6-8 mm. of the surrounding bony walls would have to be destroyed before the roentgenogram would appear indicative of cholesteatoma. That much destruction would probably already have led to intracranial encroachment although measurements in the films would indicate a normal sized antrum.

The rate of growth of a cholesteatoma is another unknown factor. Usually the enlargement of the antrum due to the bone destruction is a very slow process. Repeated roentgen studies of the same patient with intervals of eight to ten years reveal an enlargement of only 2-3 mm., sometimes more. Sudden flare-ups followed by rapid bone destruction are occasionally observed by the otologist.

CRITERIA FOR ROENTGEN DIAGNOSIS OF CHOLESTEATOMA

In the opinion of most roentgenologists, an enlargement of the mastoid antrum is the most important and indispensable feature in the roentgen diagnosis of cholesteatoma of the middle ear. According to MacMillan² the normal sized antrum is 6 mm. wide by 10 mm. high in a sclerosed mastoid. Any increase in size of the antrum

is considered to be due to erosion of the bone by growing cholesteatoma. A condensation of the periantral bone is considered as additional evidence.

The intimate spatial relationship of the antrum and attic to the very dense labyrinthine mass greatly reduces the usefulness of certain projections in the diagnosis of cholesteatoma of the middle ear. On the other hand, a certain degree of uncertainty

entire cavity. Roentgen studies of these skulls showed that most of the antrum is superimposed upon the dense labyrinthine mass in Law's position (Fig. 1, *A* and *B*). In both the Stenvers and occipital (MacMillan³) positions the entire antrum is projected laterally from the labyrinth. The occipital position (Fig. 2*B* and 4*B*) has definite advantages in demonstrating the antrum because this cavity is almost never

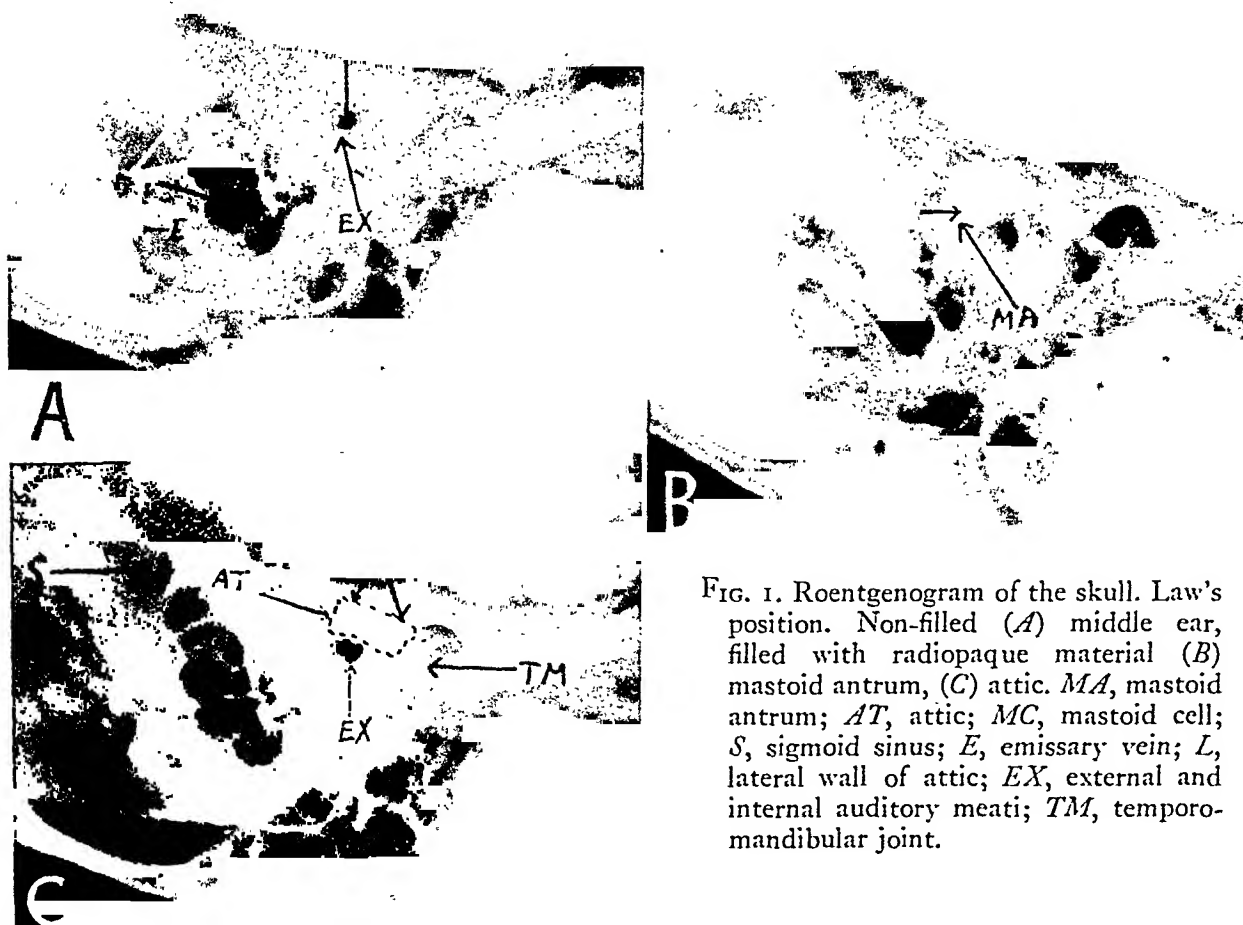


FIG. 1. Roentgenogram of the skull. Law's position. Non-filled (*A*) middle ear, filled with radiopaque material (*B*) mastoid antrum, (*C*) attic. *MA*, mastoid antrum; *AT*, attic; *MC*, mastoid cell; *S*, sigmoid sinus; *E*, emissary vein; *L*, lateral wall of attic; *EX*, external and internal auditory meati; *TM*, temporo-mandibular joint.

in identifying the different structures on the films exists many times due to the complicated interrelationships of the bony structures in the mastoid and petrous bone areas. In order to eliminate both these sources of error, dry skulls were sawed through a sagittal plane so that the attic and antrum were halved in the anteroposterior diameter without loss of their bony walls.

Antrum. Radiopaque material was first put into the antrum completely filling the

crossed by bony shadows of the base of the skull in contrast to the Stenvers position. In Mayer's position the antrum is projected into the mastoid process and the labyrinthine mass does not overlap the antrum (Fig. 3*B*). Measurement of the radiopaque filling in the skull and on the films showed negligible discrepancy within a range of 1 mm. as to the height of the antrum. The measurement of the width of the antrum did not show any variation on the roentgenogram as compared with skull

measurements. This finding is somewhat surprising in view of the fact that due to the position of the skull, angulation of the

filled in the same way. Both in Law's and Stenvers' positions almost the entire attic falls into the dense shadow of the labyrinth-

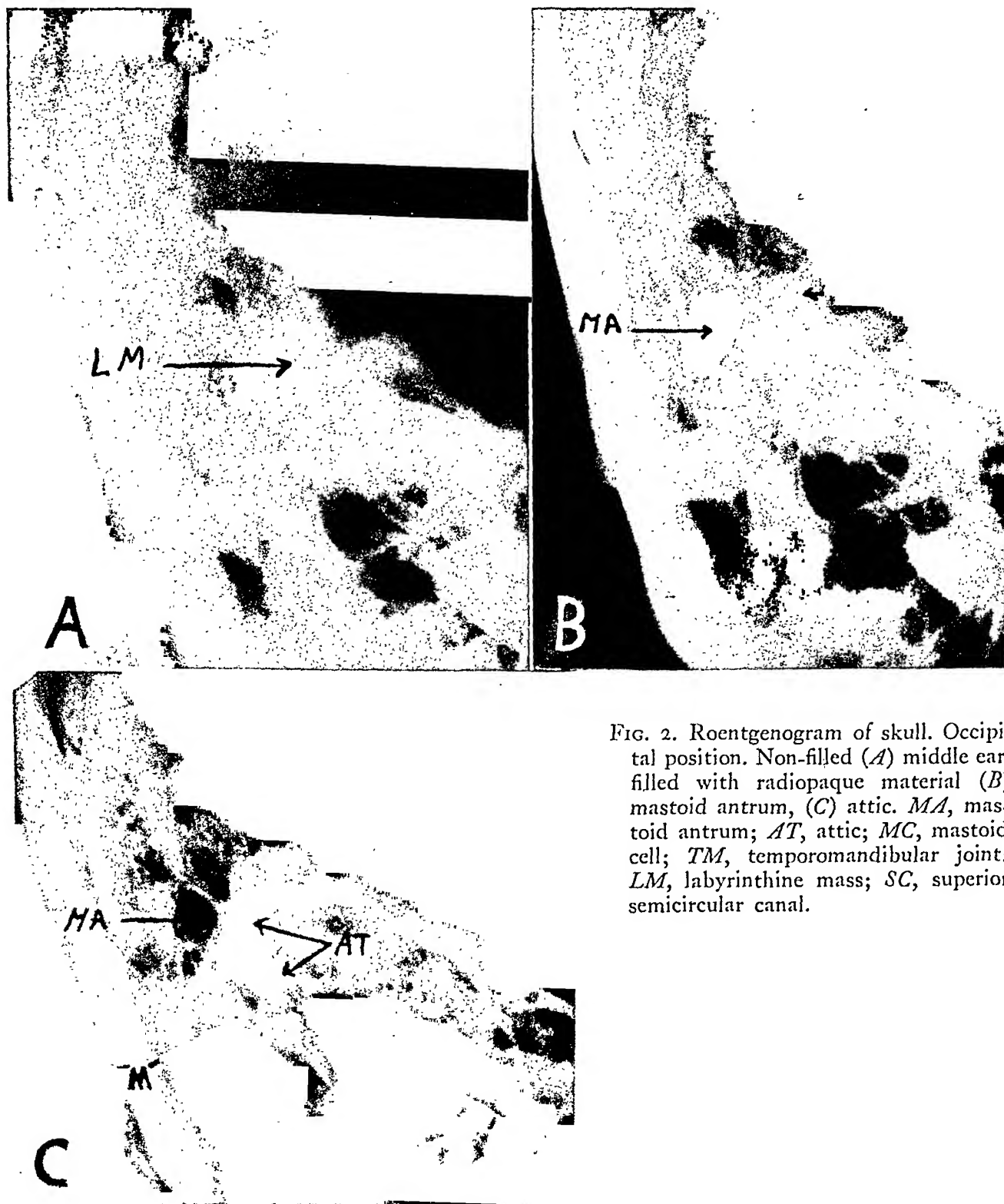


FIG. 2. Roentgenogram of skull. Occipital position. Non-filled (A) middle ear, filled with radiopaque material (B) mastoid antrum, (C) attic. MA, mastoid antrum; AT, attic; MC, mastoid cell; TM, temporomandibular joint; LM, labyrinthine mass; SC, superior semicircular canal.

roentgen tubes, and anatomical variations, a certain amount of distortion was expected.

Attic. After removal of the radiopaque material from the antrum the attic was

thine mass (Fig. 1C) and the lateral wall of the attic. In the occipital position most of the attic is projected below the dense labyrinthine shadow (Fig. 2C). In Mayer's position the labyrinth is clearly shifted

away from the attic. However, with the exception of a small portion of the attic which is projected into the tympanic cavity and the external auditory canal, the attic is covered by the lateral wall of the attic and the posterior wall of the external auditory canal (Fig. 3C and D, and 4D).

OBSERVATIONS

Roentgen studies of the mastoid were reviewed in 70 consecutive unselected cases in which a radical mastoid operation was performed. In 25 of the 70 cases, the operative findings did not confirm the roentgen diagnosis. In 17 patients cholesteatoma was found at operation while roentgen studies failed to demonstrate its presence. Out of the 17 cases, the cholesteatoma was located in the attic in 7, and in the mastoid antrum in 10. All of the attic cholesteatomas remained undetected in roentgen studies. Cholesteatomas of the mastoid antrum fared much better; of 34 cases, only 10 were not demonstrated. On the other hand, roentgenograms were thought to give the characteristic picture of cholesteatoma in 8 cases in which operation failed to reveal epidermoid pathology of macroscopic or microscopic nature.

Using enlargement of the mastoid antrum as evidence of cholesteatoma resulted in erroneous conclusions in about one-third of the cases of this series. The frequency of failure to demonstrate a cholesteatoma by roentgenograms greatly outnumbers those instances in which operation fails to reveal a cholesteatoma when the films show an apparently enlarged antrum. Routine microscopic studies helped to reduce the number of diagnostic errors in cases where gross evidence of cholesteatoma was not found at operation. Complete spontaneous liquefaction and disappearance of the cholesteatoma before operation, even though the cavity does not show macroscopic evidence of it at operation, is not likely to occur.

Law's position, occipital position (MacMillan) and sometimes Stenvers' position were used as standard techniques in the

above series. MacMillan's rule was followed as to the normal size of the mastoid antrum in a sclerosed mastoid.

COMMENT

Measurements of the mastoid antrum under the microscope necessitate certain changes as to the evidence which is generally accepted as indicative of pathological enlargement of the mastoid antrum in roentgenograms. In a considerable number of all consecutive sections of each temporal bone studied in this series, the width proved to be greater than 6 mm., which is accepted as being the upper limit of normal. Only for the inferior third of the antrum in the occipital position could 6 mm. be the limit of normal variations. Near the base of the antrum the width rarely exceeds 6 mm. As long as enlargement of the antrum is the only reliable basis for roentgen diagnosis of a cholesteatoma, our attention should be concentrated on the width of the inferior third of the antrum.

Measurements of the height of the antrum in sclerosed temporal bones showed that 11 mm. rather than 10 mm. should be considered as the upper limit of normal.

The two changes described above may help to eliminate some of the roentgenological errors leading to unnecessary operations. Radical mastoid operation, however, is essentially a prophylactic operation which is being performed in order to forestall serious complications. The otologist is justly concerned in making an early diagnosis. Most of the diagnostic errors in roentgen studies occur in early cases. Early diagnosis is impossible in the vast majority of cases while roentgen diagnosis in late cases (when the cholesteatoma has reached a considerable size) is likewise impossible in a large number of cases. One of the reasons for these failures lies in the anatomical variations both in the antrum itself and in the surrounding bony structures. It may take many years before a cholesteatoma developing in a 4 by 5 mm. antrum can be demonstrated in roentgenograms. It is obvious that a so-called pathological en-

largement of the antrum by a cholesteatoma can be demonstrated in roentgenograms much earlier if the antrum was large to begin with and surrounded by thin bone. The danger of intracranial complication, however, may be the same—being independent of the original size of the antrum.

The anteroposterior diameter of the antrum shows great variations not only from section to section but in individual sections. Due to the irregular shape of the cavity the antrum may be several millimeters shallower laterally than medially; or vice versa. A thin layer of air will be present in the shallow portion making roentgen demonstration impossible. In addition, in a significant number of cases the antrum is separated from the endocranium by a thick cortical bone. An air or cholesteatoma containing cavity located deep in the center of a large sclerotic bone does not lend itself to roentgen demonstration.

Variations in thickness of the lateral wall of the attic make demonstration of the attic quite uncertain. A 7 mm. thick sclerotic lateral wall may make roentgen demonstration of the air or cholesteatoma containing cavity of the attic impossible. On the other hand, the great variation in the size and shape of the attic in normals makes it impossible to establish normal useful values for measurement.

Tomographic examination may be helpful in visualizing cavities surrounded by thick layers of sclerotic bone.⁵

Limitations inherent in different positions are another factor that makes roentgen evidence of secondary importance in the diagnosis of cholesteatoma. Law's position does not, as a rule, give valuable information because most of the antrum and of the attic is overlapped by the dense labyrinthine mass.⁸ In addition, the lateral wall of the attic is superimposed upon the attics in this position (Fig. 1C). Large cholesteatomas extending into the sinodural angle, destroying the anterior margin of the sigmoid sinus, or breaking through the roof of the antrum and attic are exceptions

to this rule. In order to demonstrate a defect in the roof of the attic, the roentgen rays must hit the defect tangentially. Therefore a number of films taken at slightly different angles may be necessary in order to demonstrate the defect. An artificially made bony defect measuring 3 by 3 mm. could not be demonstrated in the dry skull in repeated roentgenograms. Demonstration of such pathology amounts actually to luck.

The Stenvers position demonstrated the antrum because it is overlapped only by the mastoid bone. However, the base of the skull frequently obscures visualization of the antrum in this position. A mastoid containing small cells with thick bony septa may make it impossible to obtain clear outlines of the antrum. This statement applies to all positions. Stenvers' position is of little help in the diagnosis of a cholesteatoma which is localized to the attic because this cavity is superimposed by the shadow of the labyrinthine mass.

The occipital position is more satisfactory in demonstrating the antrum (Fig. 2B and 4B), as compared with Stenvers' position. The base of the skull is rarely superimposed upon the antrum in this position. Demonstration of the attic in the occipital position is rarely possible in a satisfactory way. It was found that in roentgenograms of dried skulls taken in the occipital position, no definite outline of the attic was discernible. The exact outline of the attic was verified in the same skulls in the same roentgen position after filling the attic with radiopaque material. Roentgen studies of dried skulls in the occipital position showed that the shape and size of the antrum could not be invariably demonstrated, though a good sized antrum was visualized if the cavity was filled with radiopaque substance in the same temporal bone.

Mayer's position⁴ or its modifications satisfactorily demonstrate the antrum because the labyrinth is projected towards the tip of the petrous bone. The usefulness of this position, however, is a very limited one in demonstrating the shape and size of the attic.^{1,7,9} A dense sclerotic lateral attic wall

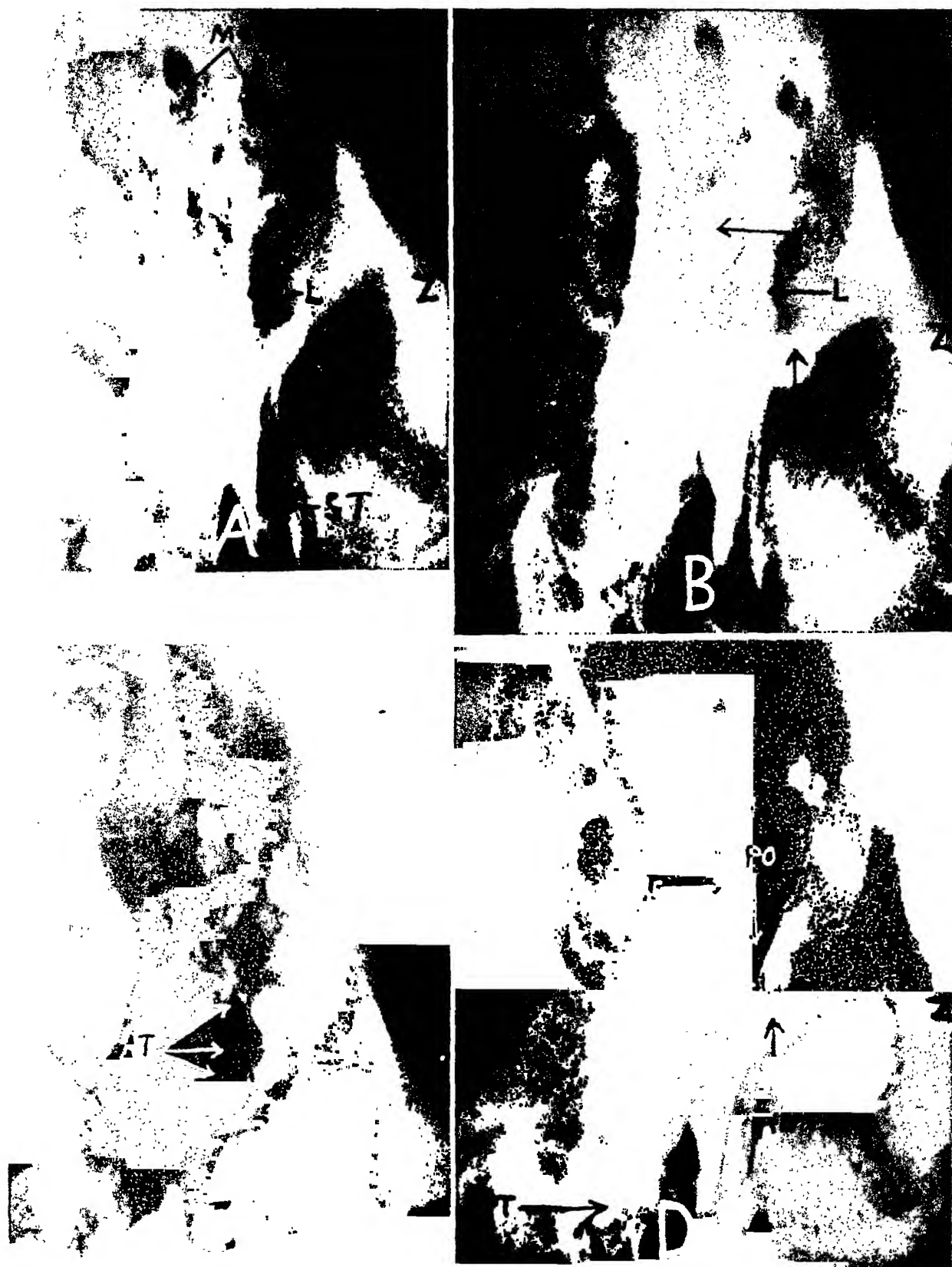


FIG. 3. Roentgenogram of skull. Mayer's position. Non-filled (A) middle ear, filled with radiopaque material (B) mastoid antrum, (C) attic. Anterior and posterior wall (D) of the bony external auditory canal coated with radiopaque material which reaches tympanic ring. Radiopaque marker on arcuate eminence and petrous tip. Note shape and size of attic cannot be demonstrated without filling. *ANT*, anterior wall of external canal; *PO*, posterior wall of external canal; *MA*, mastoid antrum; *AT*, attic; *L*, lateral wall of attic; *E*, emissary vein; *S*, sigmoid sinus; *MC*, mastoid cell; *Z*, zygoma; *PT*, petrous tip; *AE*, arcuate eminence; *ST*, styloid process.

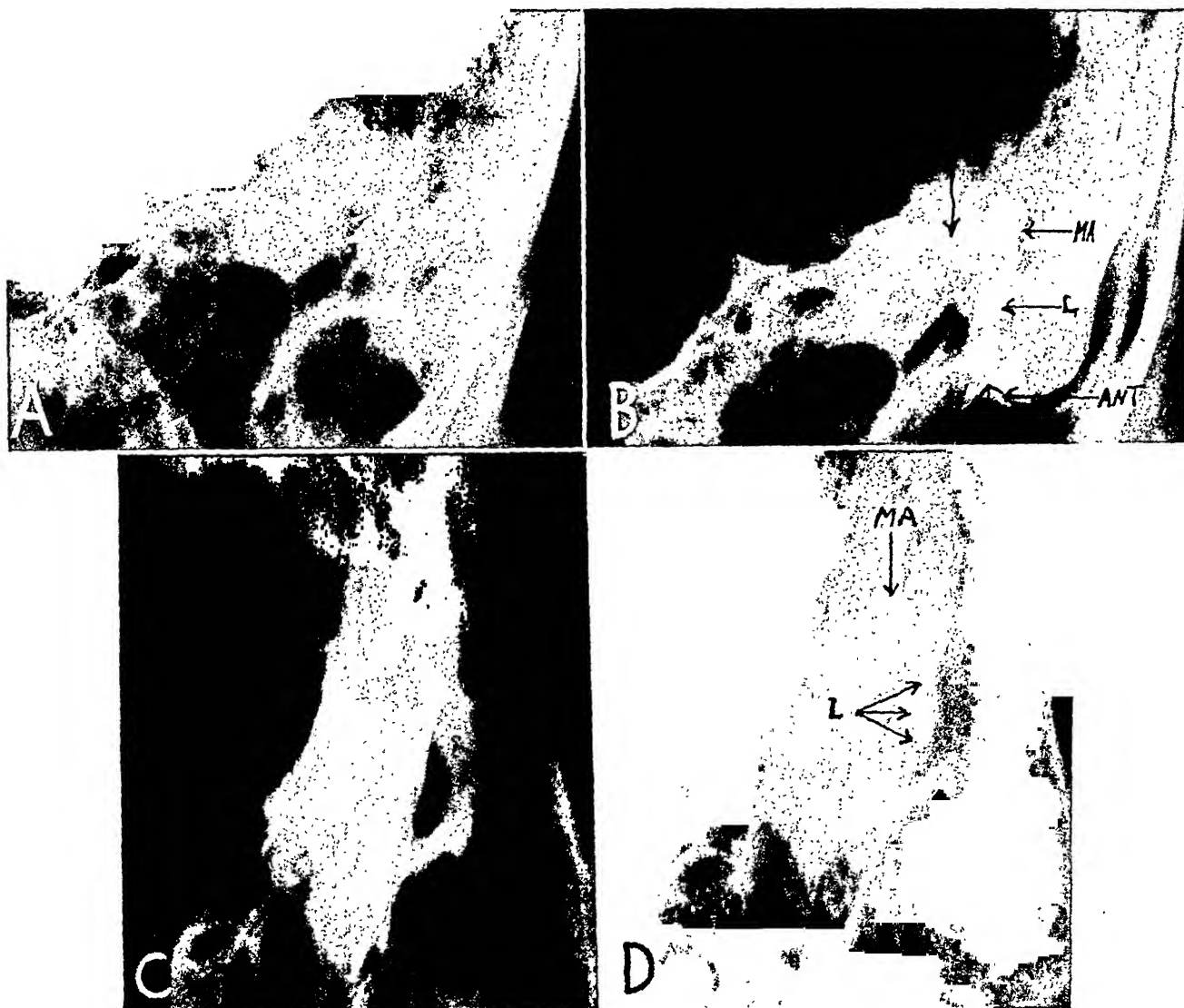


FIG. 4. Roentgenogram of skull. Non-filled (*A*) middle ear in occipital position. Mastoid antrum filled (*B*) and inner side of lateral wall of attic coated with radiopaque material in base position. Same skull without filling (*C*) in Mayer's position. Same skull in Mayer's position (*D*) with same filling as in (*B*). *MA*, mastoid antrum; *L*, lateral wall of attic; *LM*, labyrinthine mass; *SC*, superior semicircular canal; *ANT*, anterior wall of external auditory canal.

and a similar posterior wall of the external auditory canal may completely cover the major portion of the attic (Fig. 3*C* and *D*, and 4*C* and *D*). Therefore in Mayer's position the only acceptable evidence for a cholesteatoma of the attic is an extensive total destruction of the lateral wall of the attic or posterior wall of the external auditory canal. On the other hand, a large bony defect of the lateral attic wall is easily detected by otoscopic examination. In the presence of a thick lateral attic wall, a cholesteatoma of the attic may remain undetected in roentgen studies, no matter what position is used. The dura may be

pathologically exposed or a temporal lobe abscess may already be present and the roentgenograms still appear negative. Many of these complications show a notoriously symptom-poor course and both the patient and surgeon become overconfident about the potential danger, particularly in the presence of a negative roentgen report. If we keep in mind that not all otogenic intracranial complications can be cured and that a purulent labyrinthitis will invariably lead to total and irreversible deafness, we have to realize the paramount importance of the clinical examination. Especially is this true for cholesteatomas of the attic.

Out of 100 cases of cholesteatoma of the middle ear about 20 are localized to the attic. In most of them even the best roentgen studies will be of very limited help and negative roentgen findings should not be a deciding factor in the treatment of such cases.

Cholesteatoma very rarely develops in a pneumatized mastoid bone. In spite of still existing controversy on this issue, proved cases of cholesteatoma in a pneumatized mastoid bone are occasionally observed at operation. Sclerotic mastoid is the rule, however, in cholesteatomas.

"Cholesteatoma is present in practically all cases of chronic mastoiditis according to many otologists"² is a statement which cannot be confirmed in view of our histopathological data. A great number of sclerotic bones have been observed with a history of long standing suppuration in which serial sections failed to reveal any evidence of a cholesteatoma. To this group belong practically all cases in which the perforation of the drum does not extend to the epitympanic region and to the tympanic ring. The vast majority of the patients belonging to the latter group do not constitute a surgical problem and hardly any help in the management of these cases can be expected from roentgen studies. This is an important reason why a roentgen diagnosis of chronic mastoiditis should be used with great reserve.

SUMMARY

1. Measurements of the mastoid antrum of unpneumatized bones in serial sections showed that the normal antrum is wider than 6 mm. in its upper two-thirds but almost never in its lower third near the base. The upper limit of the normal height is 11 mm. with occasional exceptions up to 12 mm. Considerably smaller mastoid antra, however, occur in normal unpneumatized bones. The standard shape and size of the attic could not be established because of the numerous anatomical variations of this cavity.

2. Cholesteatomas of the middle ear can-

not be diagnosed by roentgen studies if one or more of the following conditions exist: (a) cholesteatoma fills the mastoid antrum but does not destroy its walls, (b) cholesteatoma occurs in a deeply located antrum surrounded by thick inner table and cortical bone, especially if the anteroposterior diameter is small (flat antrum), (c) cholesteatoma is present in a small antrum, (d) cholesteatoma is localized to the attic—very large cholesteatomas are exceptions under this rule, (e) cholesteatoma develops in a mastoid on which a simple or a radical operation was previously performed.

3. The only roentgen evidence of an attic cholesteatoma is destruction of the lateral wall of the attic, which, if extensive enough, can be detected in Mayer's position, or a bony defect in the roof of the attic which is occasionally demonstrated in Law's position. Both of these lesions represent a late stage of the disease.

4. Demonstration of the attic on roentgenograms is not possible in the projections known, including Mayer's position.

5. Roentgen studies of cholesteatoma of the middle ear lead to erroneous conclusions in about one-third of all operated cases. The vast majority of roentgen diagnostic errors occurs in cases in which cholesteatoma is found at operation while preoperative roentgen studies failed to demonstrate their presence. All cases of attic cholesteatoma remained undetected in this series. In an average of twenty out of one hundred cases, the cholesteatoma is localized in the attic.

6. An enlarged antrum in roentgenograms indicates cholesteatoma only if it is associated with an epitympanic, marginal perforation of the drum. If there is a contradiction between clinical findings and the roentgen studies, the treatment of the case should be directed by the clinical evidence.

7. Close cooperation between the otologist and roentgenologist is essential in reaching useful conclusions and will result in improved diagnostic procedures.

I wish to acknowledge with much appreciation

the great help given me by members of the Department of Radiology, Dr. Lois Collins and Miss Anne Piper.

622 West 168th St.
New York 32, N. Y.

REFERENCES

1. DANIELIUS, G. Value of axial projection of petrous bone in diagnosis of chronic mastoiditis and cholesteatoma. *Radiology*, 1944, 43, 492-498.
2. GRIER, G. W. Roentgen-ray examination of the paranasal sinuses and mastoids. In: Golden, Ross, Editor. *Diagnostic Roentgenology*. Thos. Nelson & Sons, New York, Vol. I, 1941, p. 59B.
3. MACMILLAN, A. S. Cholesteatoma in chronic otitis media. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1936, 36, 747-750.
4. MAYER, E. G. *Otologische Röntgendiagnostik*. J. Springer, Vienna, 1930.
5. MUNTEAN, E. Der Beitrag der Röntgenschnittuntersuchung zur Frühdiagnose des "Cholesteatoms." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1942, 65, 279-290.
6. MYGIND, S. H. Indications for radical operation in chronic middle-ear suppuration. *J. Laryng. & Otol.*, 1932, 47, 297-315.
7. OWEN, G. R. Simplified method of producing axial view of Mayer in chronic mastoiditis and attic cholesteatoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1947, 57, 260-263.
8. VON LEDEN, H., and WILLIAMS, H. L. Cholesteatoma with fistula into the labyrinth. *Arch. Otolaryng.*, 1944, 39, 432-433.
9. WINDHOLZ, F. Use of x-ray in chronic mastoid condition. *Laryngoscope*, 1946, 56, 612-615.



MALIGNANT DEGENERATION OF BENIGN GIANT CELL TUMOR OF BONE*

By T. LEUCUTIA, M.D., and JAMES C. COOK, M.D.

Department of Radiology, Harper Hospital

DETROIT, MICHIGAN

RECENTLY an increasing number of articles have appeared in the literature considering irradiation with roentgen rays and radium as hazardous in the treatment of benign giant cell tumor of bone. It is admitted by a large majority of the investigators that radiation therapy in most instances leads to satisfactory anatomic and functional results and that the outlook for a permanent cure is good. However, cases are being continually observed in which after many years malignant osteogenic sarcoma arises at the site of the original benign giant cell tumor, often with fatal results. There is now a tendency to attribute to the roentgen rays a certain contributory role in such a development and therefore an effort is being made to re-evaluate the therapeutic approach in non-malignant tumors of the bone.

It is the purpose of the present article to study the various possibilities leading to a malignant degeneration of benign giant cell tumors of the bone and to analyze the relative incidence of such degeneration following different methods of treatment. In doing so, perhaps there is a certain advantage in first discussing the possibility of malignant degeneration due to irradiation. Here, a sharp distinction must be made between the cases which were grossly over-irradiated and those in which the customary doses and technique were used. Then, to gain a comparative evaluation, the possibility of a spontaneous malignant degeneration is considered. Finally, the rather voluminous literature dealing with the occurrence of sarcomatous changes following various surgical procedures or other methods of treatment is reviewed. To this a series of personal cases is added

and the significance of the several possible causative factors is discussed.

MATERIAL

The study is based on a series of 77 cases of benign giant cell tumor of bone, treated at Harper Hospital, Detroit, from 1923 to 1947 inclusive. The method of treatment consisted of curettage and postoperative roentgen therapy from 1923 to 1929 and of roentgen therapy as the principal procedure since 1930. The detailed technique of the roentgen therapy was described in former publications.^{9,18}

In the entire group, 5 of the cases are known to be dead, 3 from incidental disease and 2 as a result of subsequent sarcomatous change of the benign giant cell tumor. Five cases are untraced, 1 of which had a malignant degeneration of the benign giant cell tumor. In an additional 4 cases a sarcomatous change of the benign giant cell tumor developed, but after further treatment, either by surgery or irradiation, a satisfactory final result was obtained.

Thus, the number of the cases showing malignant degeneration was 7 out of 77, or approximately 9 per cent. All of the cases are presented in detail. In 4 of them the malignant degeneration occurred following routine roentgen therapy, in 1 it apparently was spontaneous and in 2 it followed surgical procedures. An eighth case is included, in which fibrosarcoma of the sternum developed eighteen years after gross over-irradiation for thymic enlargement.

The Development of Sarcoma in Grossly Over-irradiated Bone. Any tissue that has been grossly over-irradiated undergoes degenerative changes which after many

* Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1946.

years may culminate in malignant neoplasia. If the effect was superficial the changes appear primarily in the epithelium of the skin, leading to marked atrophy followed later by ulceration, secondary infection and eventually by the development of carcinoma. If the action occurred in the deeper layers of the body, the late sequelae may consist of degenerative processes of the connective tissue elements resulting in sarcoma of the soft parts or bone. A study of the relative incidence shows that with roentgen rays, especially of the lower voltage variety, the carcinoma is very much more common than the sarcoma. In 1940, 28 cases of malignant roentgen neoplasms which followed excessive doses of roentgen rays were reviewed at Harper Hospital.³¹ Of these 25 represented carcinomas and only 3 were sarcomas, 2 having been classified as being of subcutaneous origin, and 1 mixed, of subcutaneous and osseous origin. However, when radium, or any other member of the naturally radioactive families, is absorbed internally, as was the case with the ingestion of the luminous dye in the watch dial painters or with the drinking of radioactive waters, an irreversible deposition occurs in the bone, leading to the formation of osteosarcoma in a large majority of the cases. The same situation arises when a radium salt solution is injected into a joint or into the soft tissues lying close to the bone.

A study of the group of cases observed at Harper Hospital revealed that it made little difference whether the over-irradiation was accomplished by the administration of a single large dose or of repeated smaller doses, or by the continuous action over a long period of time of minimal doses, as is the case with radium. If the tissue changes once became permanent, a subsequent malignant degeneration at any later time could not be precluded, despite the complete discontinuation of the irradiation or any other precautionary measure. The following case of roentgen sarcoma illustrates this point.

CASE I. H. B., white female, was first seen at

Harper Hospital on January 2, 1936, at the age of twenty-one years.

The patient gave a history of having received roentgen treatment over the upper chest when she was three years old, apparently for enlargement of the thymic gland. The physician who administered the treatment has died since then and therefore the factors of the irradiation could not be secured.

A rather marked telangiectasis and atrophy of the skin of the treated area developed early in life. At the age of seventeen the skin started to break down and the patient had two minor operations for removal of ulcers and cornifications.

When examined at Harper Hospital on January 2, 1936, there was a large area of telangiectasis of the upper chest and lower neck anteriorly. Throughout this area there were several cornified excrescences, giving the impression of hyperkeratoses and near the right clavicle there was a larger tumor suggestive of malignant degeneration.

From January 2 to March 31, 1936, the patient was hospitalized and several plastic operations with skin grafts were done.

The microscopic examinations of several specimens of the skin revealed changes incident to over-irradiation. The report on the tumor was that of a fibrosarcoma of rather active growth capacity (Fig. 1).

By October, 1936, the patient developed several new tumors, chiefly at the borders of the grafts, and at this time there was a beginning involvement of the sternum. Since further operation was out of the question, supervoltage roentgen therapy was started, despite the fact that the patient already had severe irradiation injuries.

Several series of treatments were given with rather large total doses. The sarcoma, however, continued to progress. On September 13, 1937, there was already a large fungating mass arising from the sternum and there was evidence of metastases to the right supraclavicular and lower cervical lymph nodes (Fig. 2).

The patient received additional roentgen therapy until February, 1938, when it was discovered that she was two months pregnant. On April 11, 1938, she was given 104 mg. of colloidal lead phosphate intravenously, but no further irradiation. The impression was gained that the pregnancy did not substantially influence the rate of growth of the sarcoma. On

June 15, 1938, the patient moved to another state.

Information was gained through a friend of the patient that she died in August, 1938, the outcome of the pregnancy being unknown.

In the light of this observation it may be of interest to review briefly the literature giving examples of osteosarcoma produced by exposure to roentgen rays or radium during the course of treatment of lesions of some other structure than the bone. Hatcher¹⁴ and Cahan and his co-workers³ collected 24 cases of osteosarcoma which followed exposure to irradiation. Of these, 17 resulted from roentgen therapy for tuberculous arthritis, 1 from similar treatment for acute arthritis, and 6 from radium treatment. The 18 cases treated with roentgen rays were published

radium were reported by Martland²¹ and Nørgaard.²¹

Martland,²¹ in 1931, reviewed the data pertaining to the damage caused by radium in the watch dial painters. Of the 18 per-

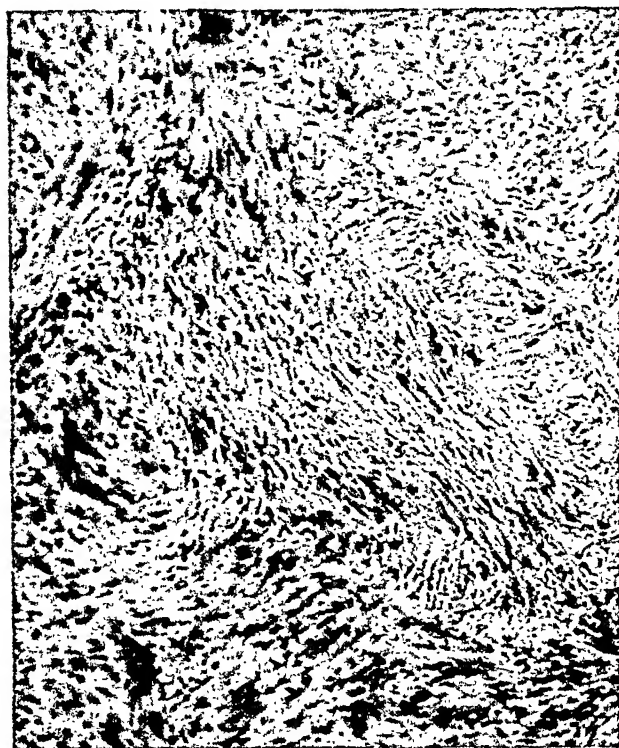


FIG. 1. Case 1. Fibrosarcoma, photomicrograph of lesion shown in Figure 2.

by 11 authors, all in the European literature, between 1922 and 1937. The given dose is not specified in the majority of instances, but the description of the sequelae indicates that they were large and extended over long periods. The 6 cases exposed to

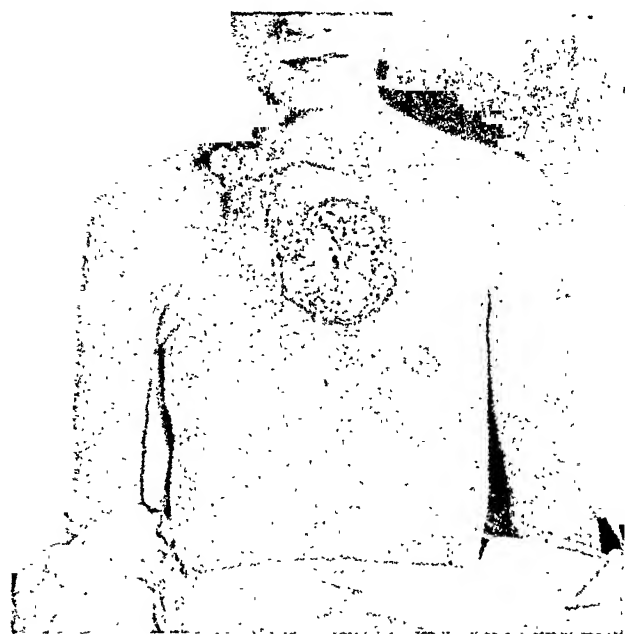


FIG. 2. Case 1. Fibrosarcoma of the soft tissues and of the sternum in a grossly over-irradiated area, eighteen years after roentgen therapy for thymic enlargement.

sons who died, 5 had bone sarcomas, 1 in the femur, 1 in the scapula, 1 in the pelvis, 1 in the pelvis and femur, and 1 in the pelvis and orbit. There were 3 additional cases of osteosarcoma who were still alive. It is stressed by Martland that, in addition to the various known forms of blood dyscrasias, severe "radiation osteitis" with pronounced deformities of the bones constituted the outstanding feature in the final stages of the disease.

Some very interesting experiments were carried out in relation to Martland's observations by Uehlinger and Schürch.³⁰ These authors placed a mixture of either mesothorium or radium (0.002-0.005 mg.) and vaseline (0.2 gm.) in the marrow cavity of the femur of rabbits and were able to produce osteosarcoma in 57 to 63 per cent of the animals within eighteen months. They also briefly describe a case in

which heavy doses of radium and roentgen rays given fourteen to eighteen years previously for a chromophile adenoma of the pituitary gland resulted in a sarcoma of the ethmoid bone.

In 1939, Nørgaard²⁴ reported a case which received treatment for chronic arthritis at the radium springs of St. Joachimsthal in Bohemia. The patient had radium baths in 1928, 1929, 1931, 1934 and 1937. In 1928 she also had an injection of radium chloride into the right shoulder joint and in 1929 two more injections into the right knee joint. A radium necrosis developed in both joints, followed eight years after the injections by a "spindle cell sarcoma and fibrosarcoma in chronic periostitis" of the proximal end of the right tibia. There are other similar cases described in the literature in which sarcoma of the bone eventually resulted from the prolonged effect of radium deposits in the skeleton. In all instances radioactivity of the osseous tissue was demonstrated at the time of the discovery of the tumor. Gettler,¹² after examining the bones of a dial painter, exhumed five years after death for litigation purposes, found that the radium was still present throughout the entire skeleton.

Hatcher¹⁴ reported 3 cases in which sarcoma had developed in bone which had been in the field of irradiation directed toward an independent lesion. In the first case, the original lesion represented a "benign chondroblastoma" of the proximal epiphysis of the tibia which was curetted and treated by intensive roentgen therapy. Four years later a sarcoma of the proximal end of the fibula appeared. The skin was pigmented and atrophic with telangiectasis but there was no ulceration. An amputation was done. Soon, metastases to the lungs developed and the patient died two years later. In the second case, the primary lesion was a benign giant cell tumor of the radial side of the right wrist. Following biopsy three radium applications were made and several series of roentgen therapy were given. Ulceration, infection and bone

necrosis developed, necessitating osteotomy of the ulna to correct deformity. Eleven years later "fibrosarcoma with tumor cartilage" of the distal end of the ulna developed. Ten years after the excision of this second tumor there was no evidence of local recurrence or metastasis. In the third case a chondrosarcoma developed in the seventh rib eleven years after roentgen therapy of a mammary carcinoma. Here no appreciable skin changes due to irradiation were present.

Malignant Degeneration of Benign Giant Cell Tumor Following Irradiation with Ordinary Doses. It is not the intention to review here the rather long series of articles dealing with the various phases of radiation therapy or the results obtained from such treatment. However, some noteworthy information may be gained from a consideration of those instances in which either individual cases or smaller groups of cases are reported as representing samples of malignant degeneration of a benign giant cell tumor incident to or resulting from the irradiation.

In the early era of radiation therapy no attention was paid to the possibility of this type of malignant degeneration. Therefore the first investigators concerned themselves mostly with a study of the value of the radiation therapy as compared to that of the surgical methods used at that time.

Later, when the results were compiled statistically, it gradually became apparent that some of the cases irradiated died subsequently with sarcomatous manifestations.

Peirce,²⁵ in 1932 and again in association with Lampe²⁶ four years later, reported a series of 40 cases treated by various methods at the University of Michigan Hospital in Ann Arbor. In 15 cases treated by irradiation alone there were no instances of malignancy, but of 8 cases treated by a combination of surgery and roentgen therapy 2 had osteogenic sarcoma. A closer scrutiny of these 2 cases, however, shows that both the surgical intervention and the irradiation were of only incidental signifi-

cance and that the divergent morphology of the tumors was the important factor. In one case the histopathologic study indicated a "chondro-osteogenic sarcoma arising in giant cell tumor" and in the other a "giant cell tumor with high degree of cellularity." This latter case at the time of the microscopic examination already had metastases to the lungs.

Francisco, Pusitz and Gerundo,¹⁰ in 1936, published the case history of a girl, nine years of age, in whom a bone cyst treated by irradiation turned into sarcoma about eight years later. At the age of nine months the patient fell and hurt her right leg. A roentgen study was made elsewhere and on the basis that the condition represented sarcoma roentgen therapy was given for a year, the factors being unspecified. The patient became worse and at this time was referred to Dr. Francisco. Roentgenograms showed a "soap bubble" central lesion in the upper end of the tibial shaft which was interpreted as a bone cyst. The leg was immobilized with cast and brace until the age of four and one-half years, when the lesion was regarded as cured. At the age of nine years the pain returned after trauma to the site of the original lesion and subsequent roentgenograms revealed an appearance of the upper half of the tibia which was diagnosed as a low grade osteomyelitis due to roentgen exposure but which on biopsy proved to be a chondrosarcoma. An amputation was done.

Doub, Hartman and Mitchell,⁷ in 1938, in studying the results in 22 cases of giant cell tumors of the Bone Tumor Registry in which radiation therapy was used found that a malignant degeneration occurred later in 3 cases. In 2 cases a combination of curettage and roentgen therapy, and in the third case roentgen therapy alone constituted the treatment. These authors also described a case of their own, originally confirmed as a benign giant cell tumor by biopsy, which within seven months of the time roentgen therapy was started with small doses developed into fibrosarcoma. The question was raised whether small re-

peated doses of roentgen rays may not have a stimulative effect leading, especially in association with traumatizing surgical procedures, to malignant transformation. In the same year Brunschwig² reported the late results in 9 cases of benign giant cell tumor which he observed periodically for five years or more after treatment. In 8 of the cases curettage followed by roentgen therapy constituted the method of treatment. The ninth case, which is described in detail, had a giant cell tumor of the lower end of the radius, which in 1921 was "scraped" and in 1922-1923 received numerous roentgen exposures and radium application, the factors being unknown. A draining sinus developed with bone necrosis, for which later sequestrectomy was performed. In 1929 the radial angulation of the hand was corrected by osteotomy above the lower end of the ulna. In 1934 a tumor of the lower ulna developed in the portion of the bone away from the former tumor of the radius. The lower segment of the ulna was removed and the histopathologic report indicated "osteogenic sarcoma of bone or giant cell tumor undergoing malignant change."

Jaffe, Lichtenstein and Portis¹⁵ in 1940 reported 3 cases of malignant degeneration in a series of 14 cases of giant cell tumors of bone. One patient died with pulmonary metastases two years after curetting, there being no history of irradiation. The second patient had originally curettement and roentgen therapy, but five years later he, too, died with pulmonary metastases following amputation of the affected lower limb, which had shown a large recrudescence of the growth. In the third patient death resulted six years later, the treatment consisting of roentgen therapy alone. On the basis of these observations, Jaffe, Lichtenstein and Portis state that "there has been an apparent increase in the number of aggressive and malignant metastasizing giant cell tumors since the era of radiation therapy began." It is "not intended to imply that carefully controlled therapeutic irradiation of a giant cell tumor is neces-

sarily hazardous in all instances, but it is disturbing enough to suggest that the problem requires renewed considerations." Jaffe¹⁶ later reported another case of bone cyst which six years after radiation therapy developed fibrosarcoma in the irradiated lesion.

Gershon-Cohen¹¹ in 1943 published the late results in a series of 29 cases of giant cell tumor of bone. Of these 14 were treated by radiation therapy alone and 14 by a combination of surgery and radiation therapy. Malignant degeneration developed in 2 cases treated by radiation therapy alone, in one six years and the other nine years after treatment. It was estimated that a total dose of 1,200 r and 6,400 r in air was given respectively.

Andersen¹ in 1945 reviewed 47 cases of giant cell tumor and osteitis fibrosa, observed at the Radium Center and the Surgical Service of the Finsen Institute in Copenhagen. A proved malignant degeneration was observed in only 1 case which was treated with 6,500 r, the roentgen irradiation constituting the sole method of treatment. In another case an osteogenic sarcoma was probably present from the beginning but remained undetected. This case will be discussed in greater detail later.

Haggart and Hare¹³ treated 7 cases of large benign giant cell tumors of bone by a combination of preoperative roentgen therapy and thorough removal of the tumor eight or twelve weeks later. The remaining cavity was packed with bone grafts. A good result was obtained in every case, the average time since treatment being 4.7 years and the longest nine years and eight months. No malignant degeneration was noted.

Very recently Cahan, Woodard, Higinbotham, Stewart and Coley³ reported 11 cases in which osteogenic sarcoma developed in irradiated bones six to twenty-four years after roentgen or gamma-ray therapy. Of these, 9 represented malignant degenerations of formerly benign giant cell tumors. In 5 cases there was microscopic proof of the benign character of the original bone

lesion, whereas in 4 cases a benign character was assumed on the basis of roentgenographic study. In all instances radiation therapy constituted the most important phase of the treatment. The remaining 2 cases were examples of bone sarcoma developing in bone underlying areas irradiated for some soft tissue lesion. One case was that of a mammary carcinoma which was irradiated following radical mastectomy. Nearly eight years later she had a malignant melanoma of the skin overlying the right deltoid muscle which was removed, together with the axillary lymph nodes. After another three years a mass in the left upper anterior chest developed. A biopsy showed that this new mass was an "osteogenic sarcoma following roentgen irradiation of bone and not a metastasis from either the breast carcinoma or the melanoma." The other case was a little girl who originally had a retinoblastoma of the right eye, which was enucleated, and six months later a retinoblastoma of the left eye which was treated by intensive roentgen therapy. Five years after the irradiation she developed an osteogenic sarcoma of the frontal plate of the left orbit. This extended to both orbits, the nasal cavity and the cranial cavity, from which the patient very soon died. The right orbital plate remained free of tumor. The authors, on the basis of these observations, concluded that "roentgen therapy is not ordinarily to be recommended for non-malignant tumors of bone."

In our own series there are 4 cases in which a malignant change was found in bone lesions originally diagnosed as benign, following roentgen therapy with ordinary technique. In Case II, however, the sarcomatous neoplasia was observed during the actual course of the treatments, so that the lesion was probably malignant from the beginning, and in Case III the roentgen dose was so small that its significance can almost certainly be disregarded. In the remaining 2 cases repeated pathologic fractures complicated the picture.

CASE II. E. F., white female, was first seen at

Harper Hospital on June 28, 1944, at the age of thirty-one years.

In March, 1944, the patient fell while working at her machine and sprained her right wrist. The injury was repeated five weeks later. She was examined in several clinics and a diagnosis of benign giant cell tumor of the lower end of the radius was made.

When seen at Harper Hospital there was a fusiform swelling of the dorsal aspect of the lower third of the right forearm, without discoloration of the skin or tenderness. Roentgenograms showed a cystic tumor of the lower third of the ulnar half of the radius with expansion of the bony cortex, suggestive of a benign giant cell tumor of bone (Fig. 3A).

On July 13, 1944, an operation was performed. The tumor area was incised posteriorly and thoroughly curetted. The cortex of the ulnar aspect of the radius was found to be of only paper shell thickness, but the articular plate was firm. The findings at operation seemed to confirm the clinical diagnosis of benign giant cell tumor.

The histopathologic report likewise was that of a "typical giant cell tumor with areas of new bone formation" (Fig. 4A).

From July 24, 1944, to March 1, 1945, four series of supervoltage roentgen treatments were given with a technique as practiced in benign giant cell tumors. The factors were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al and 3 mm. celluloid as filters; half-value layer of 9 mm. Cu and an intensity of 20 r per minute. The dose for each series amounted to 70 per cent skin unit dose, two opposite portals being used for cross-firing.

After the last series of irradiation a recurrence of the swelling of the lower forearm was noted. A roentgen study made on May 11, 1945, showed a very definite expansion and extension of the lesion of the lower end of the radius (Fig. 3B).

On May 18, 1945, a second operation was performed. The radius was disarticulated at the elbow and the ulna was amputated in its middle third.

The microscopic examination of the specimen revealed an "osteolytic spindle cell sarcoma arising in a giant cell tumor of bone" (Fig. 4B).

From May 22 to May 26, 1945 the patient received a full course of prophylactic deep roentgen therapy over the lungs.

The last examination made on July 30, 1948,

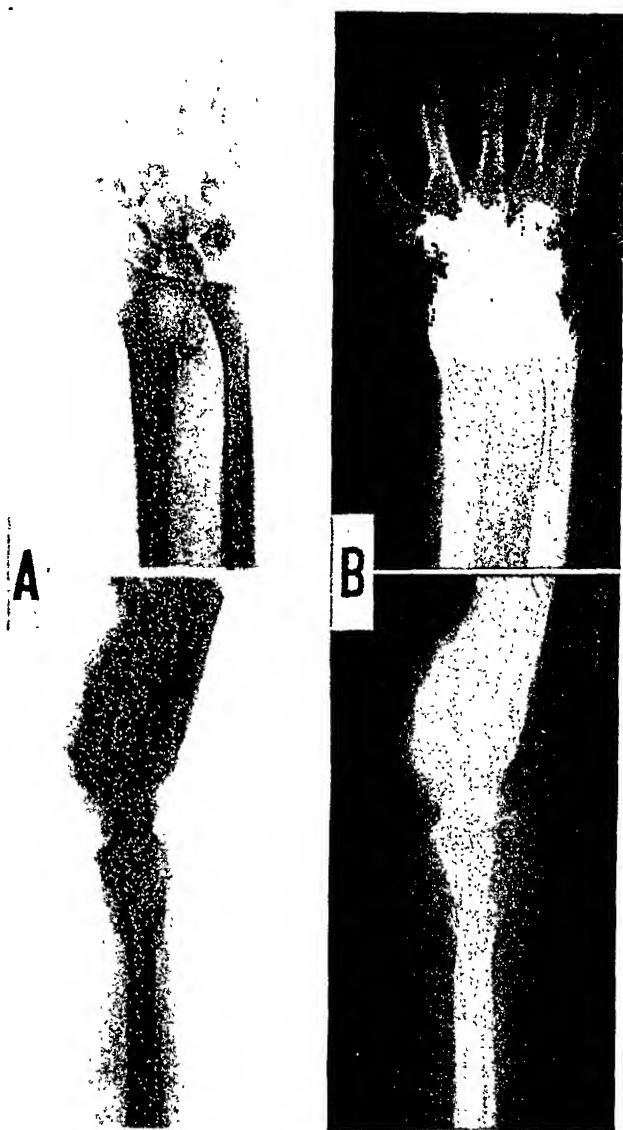


FIG. 3. Case II. A, giant cell tumor of the lower third of the radius; B, almost one year later, showing malignant change.

showed no metastases from the former bone sarcoma.

CASE III. J. D., white male, three years old when first referred to Harper Hospital on June 3, 1943.

The mother stated that in April, 1942, the patient fell and fractured the left femur. He was taken to another hospital where a roentgen examination revealed a spiral oblique fracture through a cystic area in the shaft of the left femur (Fig. 5A). Preliminary roentgenograms of other bones were negative. The left lower extremity was placed in a Bryant's traction for six days, then in a cast of plaster of paris for four months. After removal of this cast the child resumed his normal activity.

In December, 1942, the patient again fell and

a re-fracture through the same site resulted (Fig. 5B). At this time an open reduction and curettement was done, following which the extremity was placed in a Bryant's traction for six weeks and in a cast of plaster of paris for another six weeks.

The microscopic examination of the curetted material showed "young fibrous connective tissue with spicules of bone and cartilage; in a few

mm. Al filters; half-value layer of 1.9 mm. Cu and an intensity of 12 r/min. On June 9, 1943, a dose of 120 r in air was given over the left mid-thigh anteriorly and on August 11, 1943, a dose of 144 r in air posteriorly.

A roentgen examination made on November 11, 1943, showed excellent healing with complete reossification (Fig. 6B).

The patient continued to enjoy good health

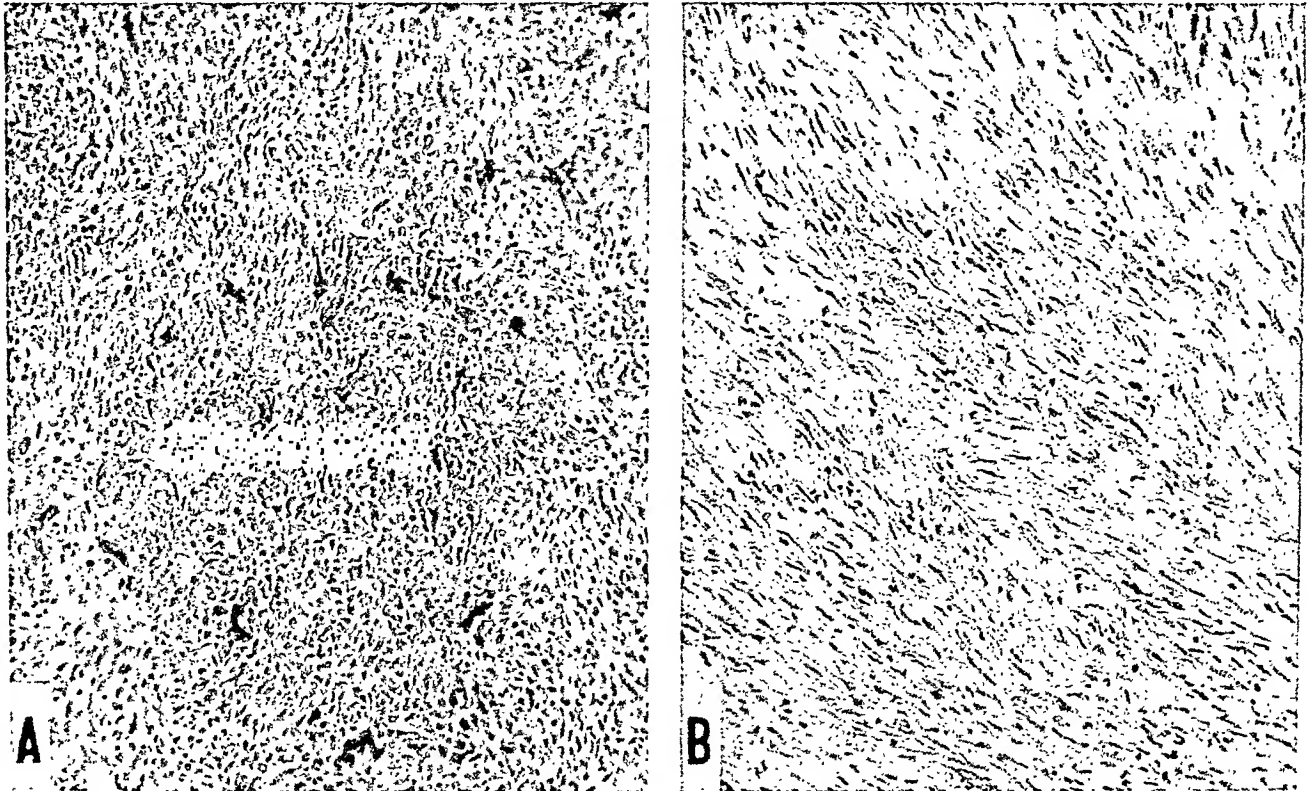


FIG. 4. Case 11. *A*, benign giant cell tumor; *B*, osteolytic spindle cell sarcoma arising in a giant cell tumor.

areas giant cells of the epulis type were found. Final diagnosis: Bone cyst" (Fig. 7A).

In March, 1943, the patient was allowed to be up and about. The thigh externally appeared normal but the child had a peculiar limp when walking.

On June 8, 1943, roentgen study revealed rather dense healing of the fracture through the pathologic area of the mid-shaft of the left femur with good alignment. However, a cyst measuring 1.5 by 2 cm. in diameter was still present producing a slight expansion of the cortex (Fig. 6A). For this reason deep roentgen therapy was recommended.

The patient received two small roentgen exposures at intervals of two months with the following factors: 250 kv., 1.5 mm. Cu and 1

until the beginning of 1948 when he started to have pain at the site of the original lesion. This was followed by a progressive swelling of the left mid-thigh and difficulty in walking.

Re-examination made on March 3, 1948, revealed a definite tumor the size of a fist located mostly at the inner aspect of the left mid-thigh and intimately associated with the bone. Roentgen study showed a typical osteogenic sarcoma involving the mid-shaft of the left femur at the site of the former bone cyst (Fig. 6C).

On March 12, 1948, the malignant nature of the tumor was confirmed by biopsy and an immediate disarticulation at the hip joint was done.

The histopathologic report of the removed

specimen was that of osteogenic sarcoma (Fig. 7B).

From March 29 to April 2, 1948, the patient received a course of prophylactic deep roentgen therapy over the lungs.

The last examination made in August, 1948, revealed no further manifestations of the osteogenic sarcoma.

CASE IV. W. C., white male, was admitted to Harper Hospital on March 12, 1936, at the age of thirty-five years.

In December, 1934, the patient sustained an intercondylar fracture of the right femur. He was hospitalized at another institution for three months during which time the extremity was immobilized. The fracture healed and the patient returned to work.

On January 3, 1936, he was struck with a crowbar on the right knee and another fracture resulted. He was treated elsewhere for a while then transferred to Harper Hospital for radiation therapy.

The examination made at the time of the admission revealed a swelling just above the right knee, the circumference of the limb being 4 cm. greater than that of the opposite side. A roentgen examination showed a multilocular, cystic tumor of the lower end of the right femur with a pathologic fracture through the involved area (Fig. 8A). The former roentgenograms made since December, 1934, were compared with the present ones. It was noted that a cystic area was already present at the original examination, it having been diagnosed as a "bone cyst." In view of the subsequent developments and the later roentgen appearance, the diagnosis was changed to that of benign giant cell tumor of bone. No biopsy was taken.

From March 13, 1936, to November 15, 1937, the patient received ten series of deep roentgen therapy with a technique such as practiced in giant cell tumor of bone. The factors were: 200 kv., 1.5 mm. Cu and 1 mm. Al filters, half-value layer of 1.9 mm. Cu and an intensity of 12-15 r/min. The initial dose amounted to 70 per cent skin unit dose, two portals being used for cross-firing. This was gradually reduced for each of the following series, until at the tenth series 10 per cent sud was given.

The fracture continued to heal satisfactorily but on June 20, 1936, the patient re-fractured it a third time, necessitating hospitalization for three months.

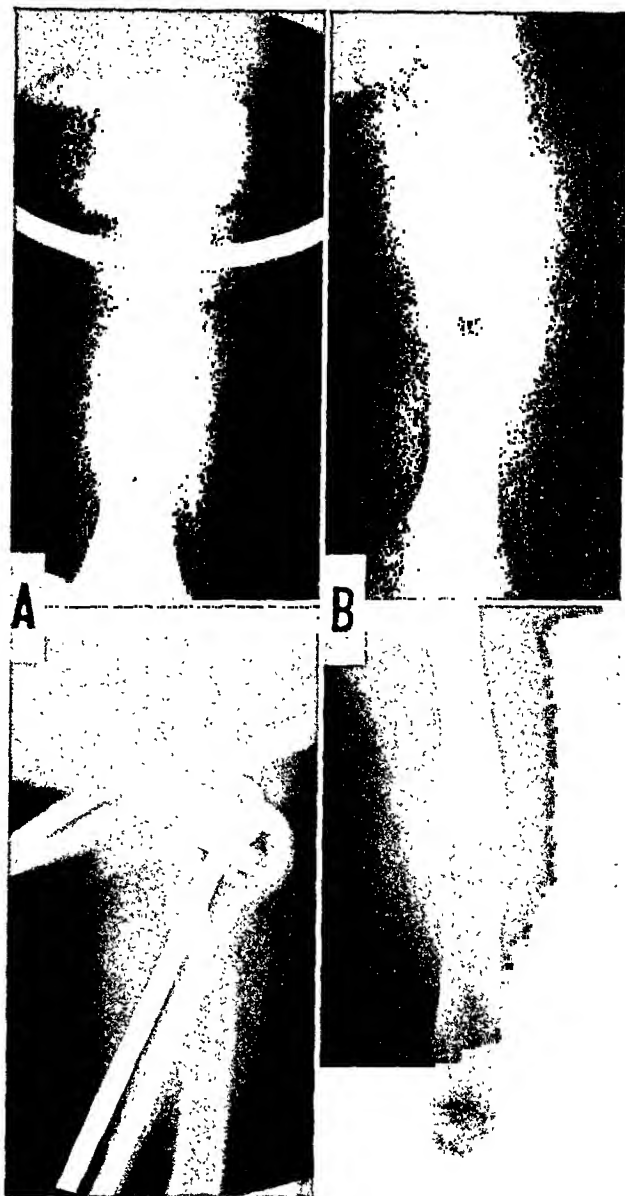


FIG. 5. Case III. A, spiral fracture through a cyst in the shaft of the left femur; B, eight months later, showing refracture.

Finally, by the end of 1937, there was an excellent healing of the lesion and the patient was walking without difficulty.

A roentgen re-examination made May 20, 1941, showed a satisfactory result (Fig. 8B).

On March 28, 1942, the patient, while on a fishing trip, fell and at this time fractured his right patella which during the course of the former treatments became fixed to the callus formed during the reossification of the giant cell tumor. The patient was re-admitted to Harper Hospital. On April 27, 1942, the lower end of the patella was removed and a suprapatellar lysis was done.

Again the patient was able to resume his

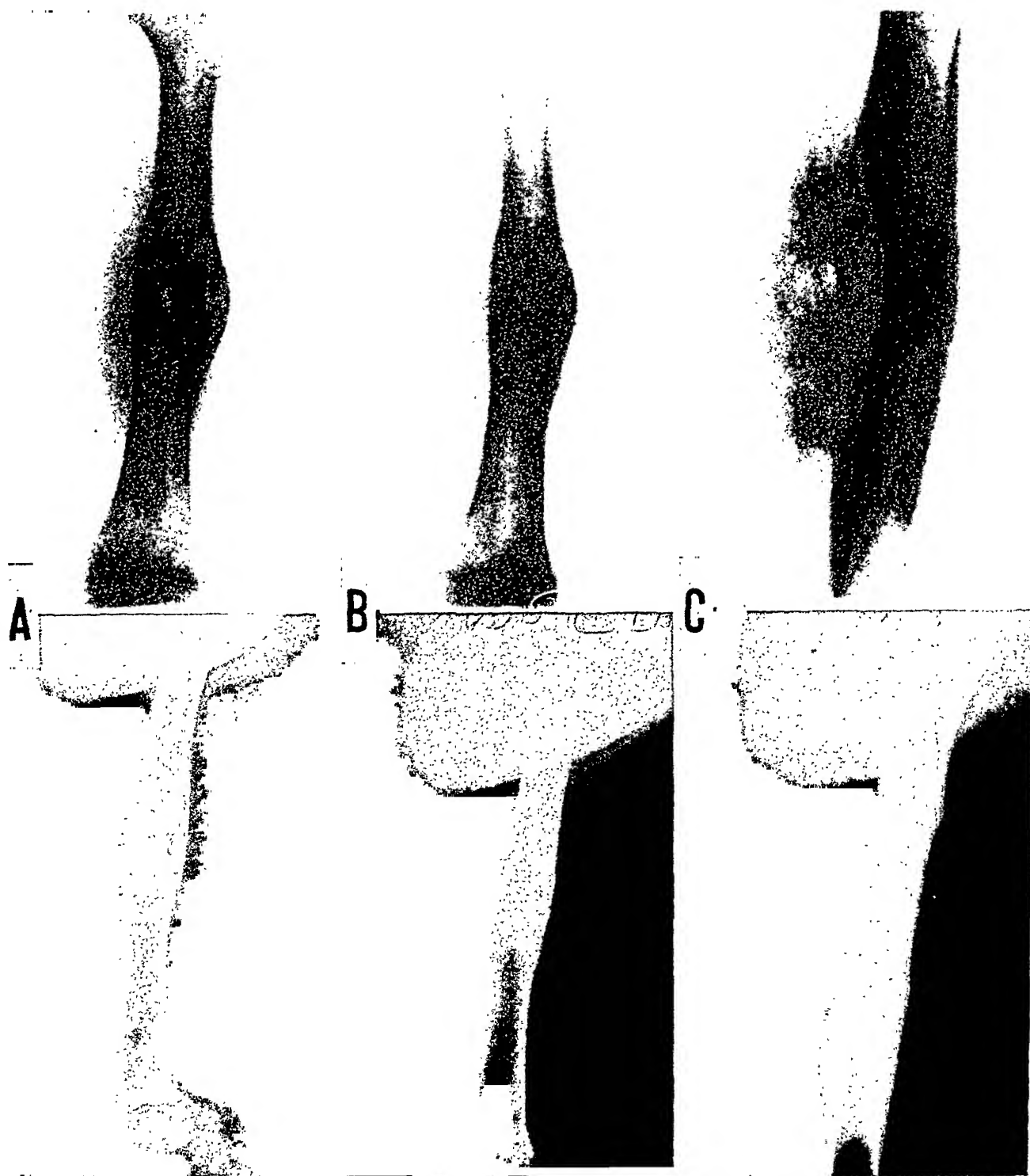


FIG. 6. Case III. *A*, same as in Figure 5, before roentgen therapy (14 months after original lesion); *B*, five months after roentgen therapy; *C*, six years after original lesion, showing osteogenic sarcoma.

occupation and he continued to work regularly.

In July, 1944, an occasional vague pain occurred in the right knee. By February, 1945, this pain became quite steady at night and rather severe.

A checkup roentgen examination made on March 6, 1945, revealed a dissolution of the bone along the outer inferior aspect of the formerly involved area of the lower right femur,

characteristic of malignant degeneration (Fig. 8C).

On March 19, 1945, a high amputation of the right lower extremity was performed.

The histopathologic examination of the specimen made by Dr. Leo W. Walker showed osteogenic sarcoma (Fig. 9).

The patient died on July 19, 1945, no detailed data being available.

CASE V. Ch. W., colored male, was first seen at Harper Hospital on February 17, 1937, at the age of thirty-one years.

The patient stated that on December 3, 1936, while working in a gas station, he fell and injured his right hip. He was admitted to another hospital where he stayed for two weeks. A diagnosis of benign giant cell tumor of the upper end of the shaft and the lower end of the neck of the right femur with pathologic fracture was made. The patient received one series

On June 18, 1937, the patient fell in a theater and sustained a second pathologic fracture. He was admitted to another hospital where traction was applied for one month. After that the limb was immobilized by a body cast and the patient discharged to his home.

A checkup roentgenogram on January 25, 1938, showed healing of the fracture with some angulation (Fig. 10B).

At this time the patient dropped out of sight and was not heard of until April 12, 1945, when

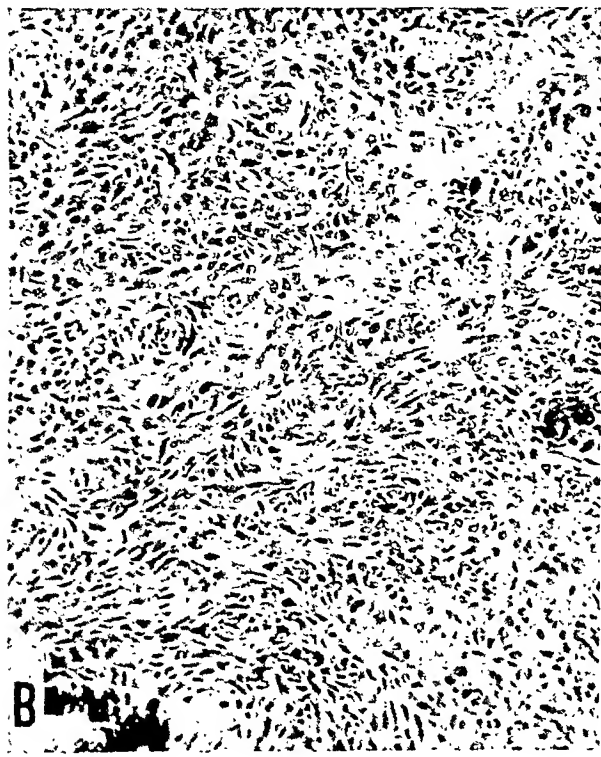


FIG. 7. Case III. *A*, bone cyst, photomicrograph of lesion shown in Figure 5B; *B*, osteogenic sarcoma, photomicrograph of lesion shown in Figure 6C.

of deep roentgen therapy. This was repeated six weeks later.

When examined at Harper Hospital, on February 17, 1937, the roentgenograms showed a large multilocular cystic tumor of the upper end of the shaft and lower end of the neck of the right femur with a fracture undergoing partial healing (Fig. 10A).

From February 17 to June 5, 1937, the patient received three series of supervoltage roentgen therapy. The factors were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al and 3 mm. celluloid filters; half-value layer of 9 mm. Cu and an intensity of 20 r/min. A tumor dose of 70 per cent SUD was given on each occasion through three portals.

he returned with a marked swelling of the right hip associated with extreme difficulty in walking. A roentgen study showed what appeared to be an advanced osteogenic sarcoma at the site of the former benign giant cell tumor of the right upper femur (Fig. 10C). A disarticulation of the right hip was recommended but the patient refused.

From April 17 to October 29, 1945, the patient received four additional series of supervoltage roentgen therapy with varying doses, merely for palliation.

A film taken June 25, 1946, showed slow increase in size of the tumor (Fig. 10D). At the present time the patient is still able to be up and around aided by a specially constructed brace.

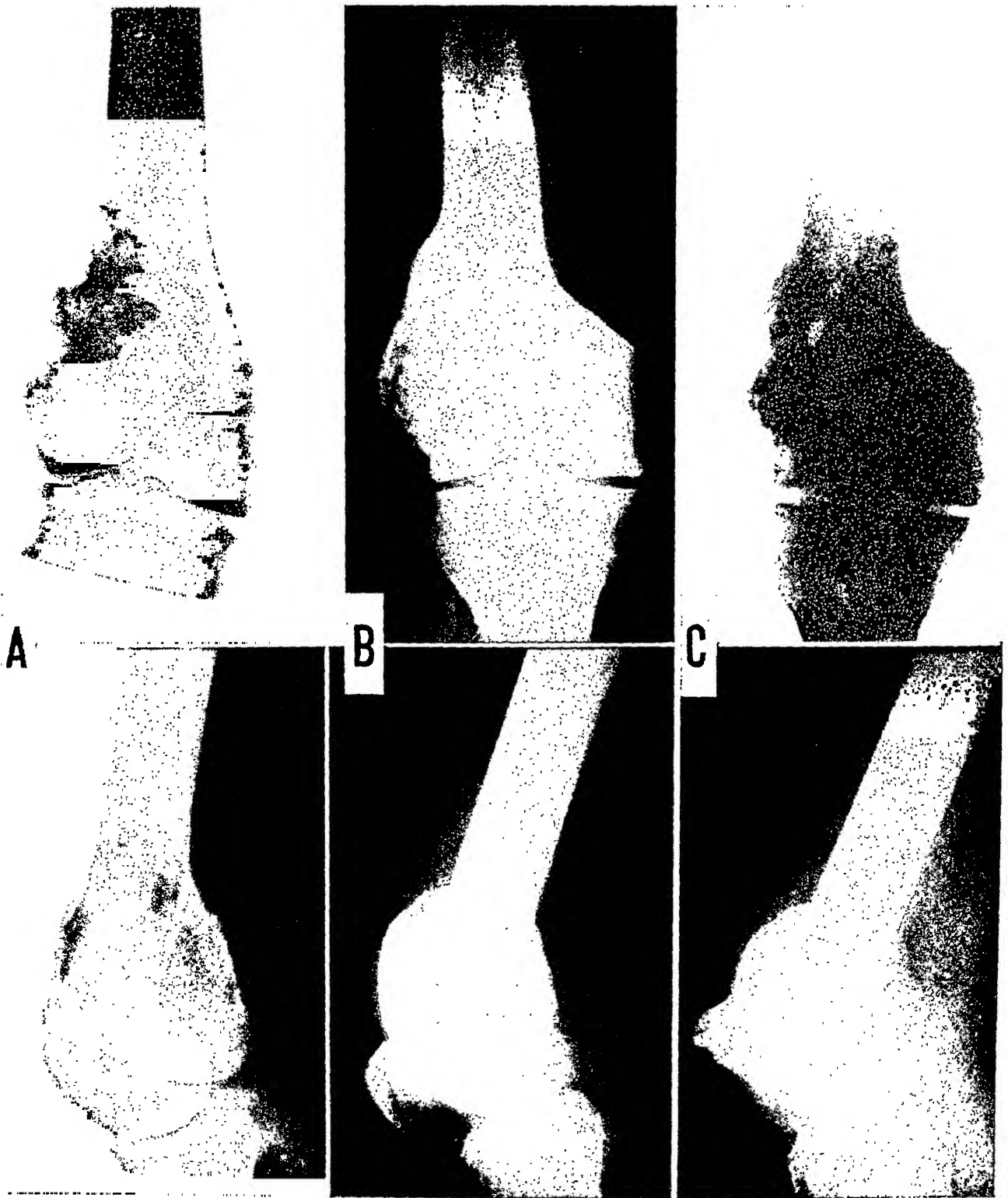


FIG. 8. Case IV. *A*, benign giant cell tumor of the lower end of the right femur, with pathologic fracture; *B*, five years later showing good healing; *C*, nine years later showing malignant degeneration.

Spontaneous Malignant Degeneration of Benign Giant Cell Tumor. As a rule, the giant cell tumor, when allowed to progress to its natural termination, grows to large dimensions, necrosis and secondary infection complicating the picture in the later stages. Death results from hemorrhage or

cachexia without evidence of regional or distant metastases.

For obvious reasons the literature is quite meager in cases showing a spontaneous malignant degeneration in benign giant cell tumors, without any treatment having been given. Kilgore and Abbott¹⁷ in

1938 described a case in which a lesion in the center of the ulnar shaft was discovered while benign, remained benign for nearly six years, then turned into chondrosarcoma. An exploration two and one-half years after the first examination revealed a benign tumor "derived from cartilage rest of fetal type and accompanied by fibrous giant cell tissue and osteitis fibrosa." After the transformation into chondrosarcoma a resection of the affected portion of the ulnar shaft was performed. Four months later a destructive lesion of the radius at its mid-portion similar to the previous ulnar tumor was found. Immediately after this an amputation at the middle and lower thirds of the upper arm was done, but the patient died nine months later with distant metastases.

A very interesting case was reported in 1947 by Andersen.¹ A coal merchant, aged fifty-one, in October, 1935, presented himself for examination because of pain in the right knee of two years' duration. Roentgen study revealed a tumor in the outer condyle of the right femur which was interpreted as a benign giant cell tumor. No biopsy was taken. During a period of five months the patient was given 10,000 r to the right knee with apparently good effect. Three years later a recurrence developed and at this time a curettage was done. The histopathologic examination revealed osteitis fibrosa. Two years later a second recurrence appeared. Additional roentgenograms were made but no biopsy was taken. The condition still resembled the picture of benign giant cell tumor. Finally the next year—seven years after the onset of the disease—there was a typical osteogenic sarcoma. Further roentgen irradiation and amputation remained ineffective and the patient died six months later. The author in reviewing the case compared the microscopic slides from the curettage with those obtained from the amputation and arrived at the conclusion that the tumor was from the beginning "an only slightly malignant osteogenic sarcoma which for several years has masked itself as a benign giant cell

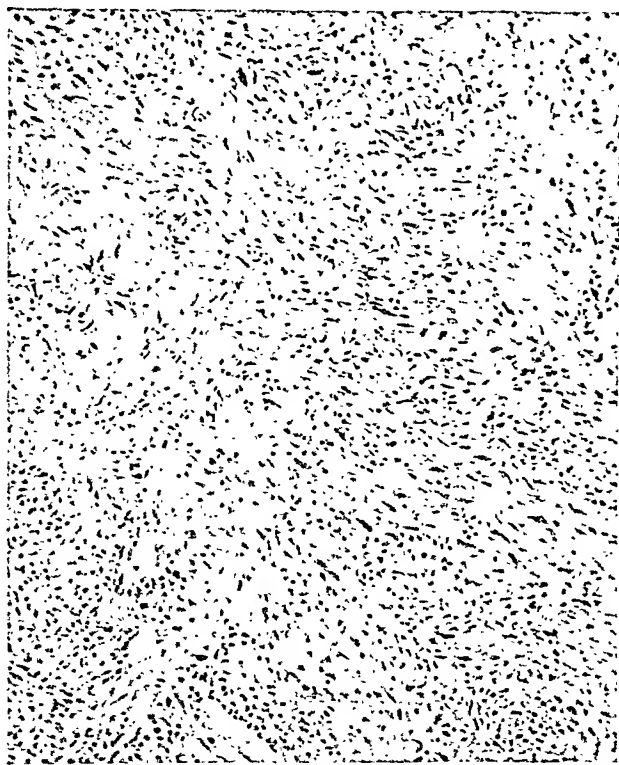


FIG. 9. Case IV. Osteogenic sarcoma; photomicrograph of lesion shown in Figure 8C.

tumor and in that time gradually has become highly malignant."

There are a few other individual cases mentioned by various investigators in which apparently benign giant cell tumors after many years spontaneously changed into highly malignant sarcomas. Different theories have been advanced to explain this transformation. A number of investigators think, like Andersen, that such tumors are malignant to begin with but remain inactive for a shorter or longer period, then all at once exhibit a rapidly fatal malignant course. Others are of the opinion that the assumption of malignant characteristics actually represents metaplasia in a manner similar to that observed in osteochondromas, fibromas, myxomas and other benign tumors which are known not infrequently to become sarcomatous.

In our own series there is one case which might be interpreted as a spontaneous degeneration of a bone cyst into an osteogenic sarcoma.

CASE VI. M. Sh., white female, aged sixty, was first admitted to Harper Hospital in May,

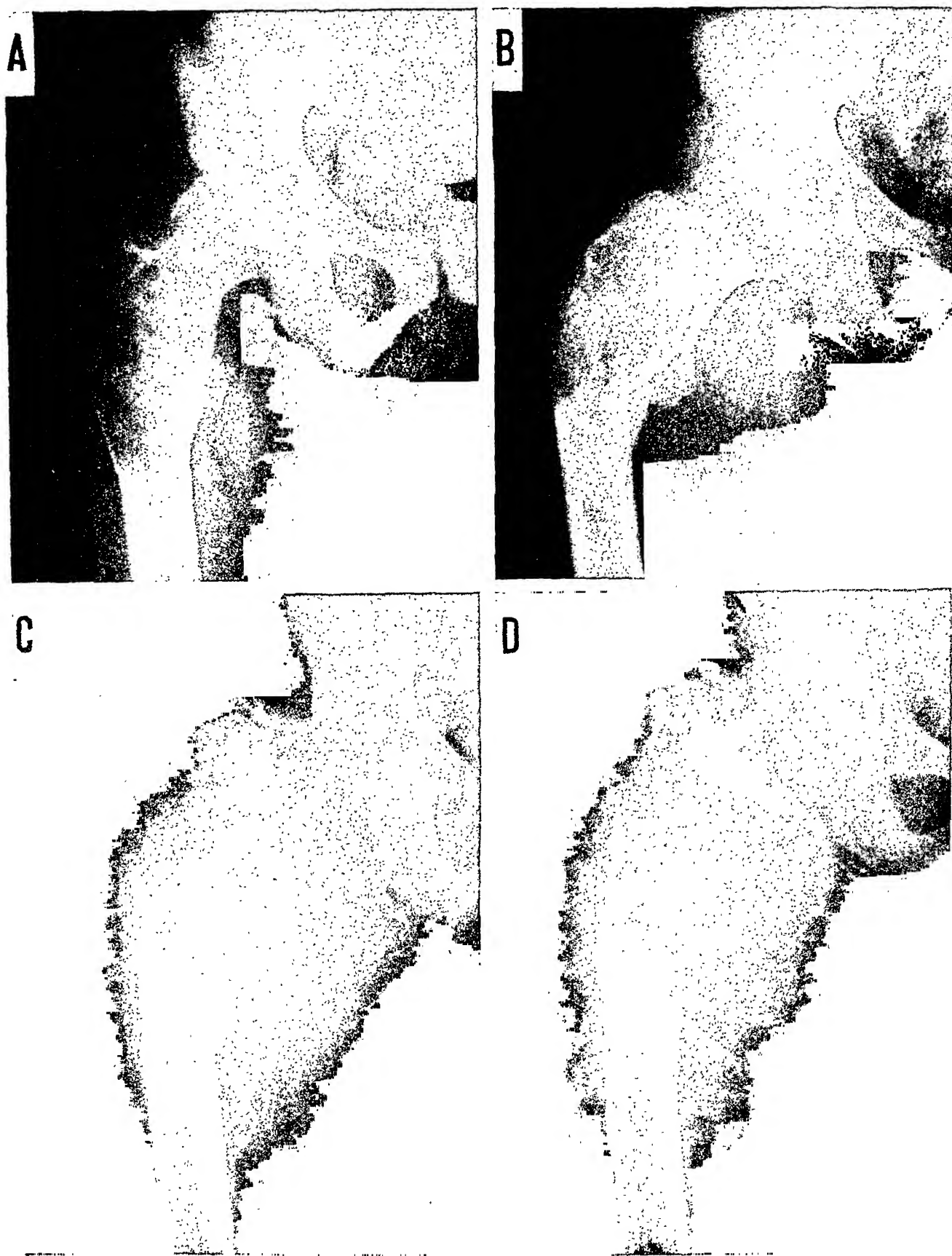


FIG. 10. Case v. *A*, benign giant cell tumor of the upper end of the left femur; *B*, one year later; *C*, eight years later showing malignant degeneration; *D*, nine years later.

1939, for treatment of extensive diverticulosis involving the sigmoid colon. At this time the patient also complained of pain in the right

knee, with difficulty in walking, of several years' duration. A roentgen examination of the right knee made on May 19, 1939, revealed a

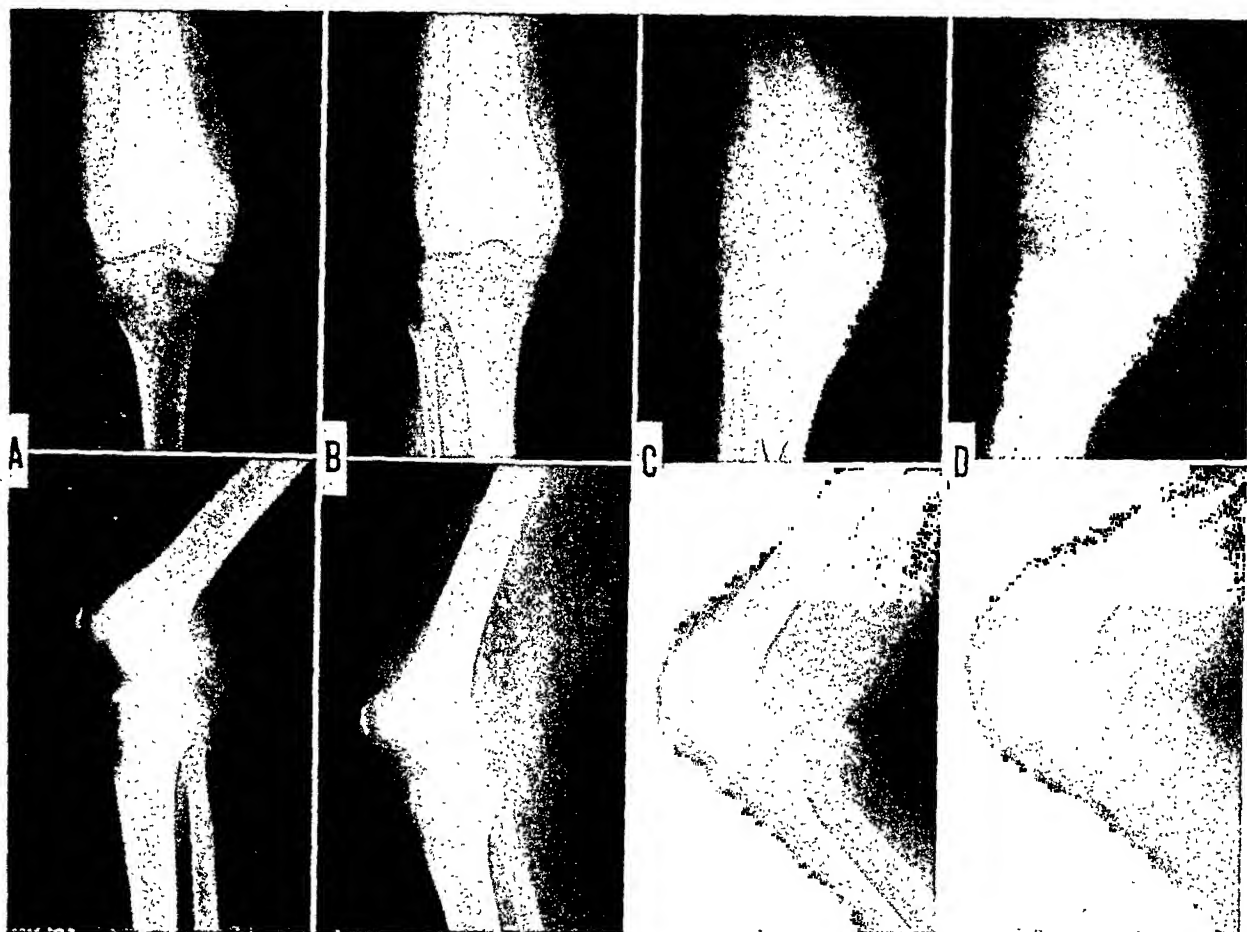


FIG. 11. Case VI. *A*, bone cyst of the external condyle of the right femur; *B*, one year later; *C*, three years later, interpreted as benign giant cell tumor; *D*, four and one-half years later showing malignant degeneration.

cystic area of the external condyle of the right femur (Fig. 11*A*). A biopsy was recommended but the patient refused.

After her discharge from Harper Hospital the patient consulted various physicians and had different types of physiotherapy, including electrical treatments and diathermy.

On May 22, 1940, she returned to Harper Hospital for a checkup examination. Roentgenograms revealed no change in the cystic area (Fig. 11*B*). Again a biopsy was recommended and refused.

The patient was then not seen until May 4, 1942, when she returned with a rather marked swelling of the right knee associated with very intense pain. She stated that for about one month she was forced to walk with the aid of crutches, being unable to put her weight on the right lower extremity. A re-examination at this time revealed a definite tumefaction just above the outer aspect of the right knee. Roentgenograms showed a lesion involving the entire external condyle and part of the lower shaft of the femur with an intercondyloid pathologic

fracture (Fig. 11*C*). A clinical diagnosis of benign giant cell tumor of bone was made and radiation therapy recommended.

From May 19, 1942, to July 7, 1943, the patient received seven series of supervoltage roentgen therapy. The factors were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al and 3 mm. celluloid filters; half-value layer of 9 mm. Cu, and an intensity of 20 r/min. The dose amounted to 70 per cent SUD, given through two opposite portals, for each of the series. First there was definite improvement but from the fifth series on it became increasingly evident that the condition represented a sarcoma (Fig. 11*D*). Surgical intervention was again recommended but the patient persistently refused.

Finally in November, 1943, she gave her consent to the operation and on November 10, 1943, an amputation at the junction of the upper and middle thirds of the right thigh was performed.

The histopathologic examination of the specimen revealed "osteogenic sarcoma" (Fig. 12).

Soon after the operation this patient moved

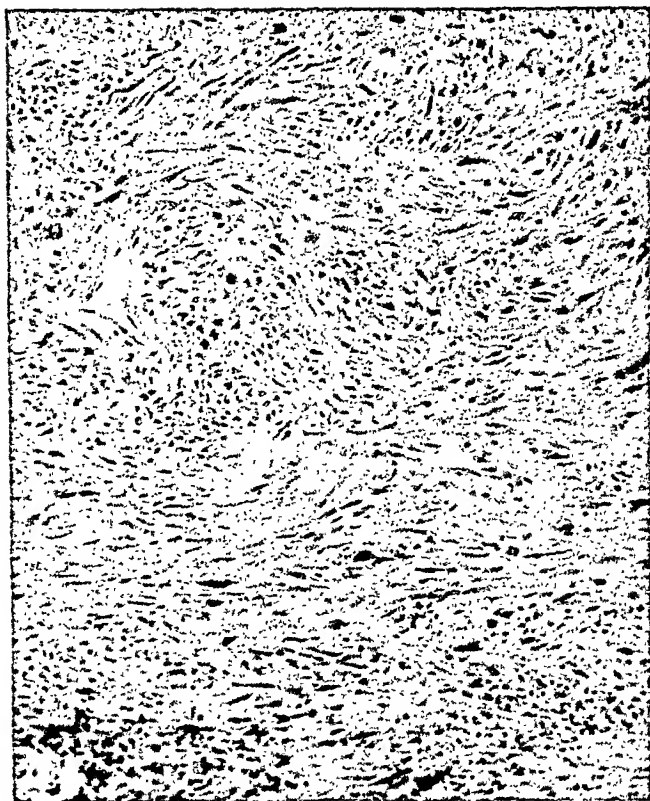


FIG. 12. Case vi. Osteogenic sarcoma; photomicrograph of lesion shown in Figure 11D.

and the final outcome of the case is therefore unknown.

Malignant Degeneration of Benign Giant Cell Tumor Following Surgery. There are a number of articles in the literature dealing with the subsequent occurrence of sarcoma or other malignant manifestation in cases of giant cell tumors of bone which were treated by surgery. The first of such articles is apparently that of Stone and Ewing²⁹ which was published in 1923 and which for many years has created considerable discussion. These authors refer to a young man who at the age of nineteen years became afflicted with a giant cell tumor of the head of the tibia. The lesion was treated by repeated curettage, one intracavitary application of radon seeds and later amputation. The patient died six months after the amputation with lung metastases. The next year MacGuire and McWhorter¹⁹ reported a series of 20 cases of giant cell tumor, 4 of whom died with metastases to the lungs. Three were treated by curettage or amputation and in the fourth a combination of curettage, intracavitary radium and external roentgen therapy was used.

In 1931, Simmons²⁷ in a more comprehensive article reviewed 116 cases of benign giant cell tumor collected by the Registry of Bone Sarcoma of the American College of Surgeons. The cases were treated by various means prior to 1925 and 82 of them were followed up for a period of five years or longer. In the entire group 6 patients died from metastases. In the same year a single case who died with metastasis was also reported by Dyke.⁸ The giant cell tumor was described as having resulted from injury. Following curettage and later amputation the patient developed metastases to the lungs and died.

W. B. Coley⁶ in 1935 expressed the view that 15 per cent of those diagnosed as benign giant cell tumors by experienced pathologists later become malignant. He, personally, reported 19 cases. In 7 the treatment consisted of a combination of curettage and roentgen therapy, in another 4 of a combination of irradiation and late amputation, in 7 of surgery alone, and in 1 of roentgen therapy alone. In a later article, B. L. Coley and Higinbotham,⁵ in reviewing their experience in 124 cases of giant cell tumor of the bone, state that "from a practical standpoint, one should bear in mind that infrequently, but by no means rarely, a giant cell tumor may exhibit all the characteristics of a benign lesion, even to the histological appearance, and yet run a course that shows it to be a malignant sarcoma." In this series 1 case came to amputation for local malignant change following surgery alone and 6 cases following surgery and radiation therapy combined.

A very instructive article was published in 1937 by Codman⁴ who studied the result of various types of treatment in a group of 153 cases of giant cell tumor about the knee listed in the Registry of Bone Sarcoma of the American College of Surgeons from 1920 to 1936. Of these, 100 cases were followed up for five years or longer and 50 for ten years or longer. An additional group of 12 cases which were chosen from over 600 cases of malignant tumors of bone about the knee joint showed a great resemblance to giant cell tumor of bone

roentgenographically but biopsy proved them to be malignant. In the group of 153 cases which were classified as benign originally, 14 cases showed malignant characteristics later. According to Codman, "it would be unfair to say that they all became malignant for in most of the 14 cases the original slide was not available." Therefore, to gain a better idea about the possibility of malignant transformation, they were divided into two groups: (1) cases in which both roentgenograms and slides were interpreted as giant cell tumor yet the disease assumed a rapidly fatal course, all patients dying within five years; and (2) cases in which roentgenograms, slides and the clinical course for several years made the diagnosis seem assured, yet eventually sarcoma appeared at the site of lesion. There were 8 cases in the first group: in 5 the type of treatment was not specified and in the remaining 3 surgery alone was used (curettage followed by amputation in 1 and amputation in 2). The second group contained 6 cases: in 2 the treatment was not specified, in 1 surgery alone and in 3 roentgen therapy alone was used. The impression was gained by Codman that whereas in the first group an error of interpretation of the type of the original tumor may have taken place, in the latter group a malignant transformation of the benign giant cell tumor may be assumed.

Stewart, Coley and Farrow,²⁸ in 1938, reported 6 cases of giant cell tumor of bone which became malignant. Of these, 3 were treated by roentgen therapy alone, 2 by curettage, and the sixth represents the case of Stone and Ewing²⁹ already referred to. A seventh case was added which was found to be malignant from the beginning. In all cases, except the sixth, the malignant characteristics were discovered within one to three years after the original diagnosis. Therefore the impression was gained that "there are tumors which show malignant features from some early period but which are, to all intents and purposes, identical in nature with the benign giant cell tumor and which are distinct from osteogenic sarcoma in the accepted sense."

Meyerding²² in 1941 reviewed 124 cases of giant cell tumors of bone which were observed at the Mayo Clinic from 1916 to 1940. He divided them into two groups: the benign giant cell tumor and the malignant giant cell sarcoma. Of the entire series 101 cases were classified as belonging to the first group with a five year cure of 97 per cent, and 23 as belonging to the second group with a five year cure of 65 per cent. The treatment consisted of various methods, among which surgery and radiation therapy, either alone or combined, occupied the most important part. On the basis of the study, Meyerding arrived at the conclusion that "in giant cell tumors that are apparently benign malignant changes may develop in time after surgical procedures or irradiation, or after a long period."

In 1945, Meyerding²³ published the results in 40 cases of benign giant cell tumor of bone treated from 1913 to 1943 by resection or excision and bone grafting. Of these, 26 patients had no previous treatment, 4 received only radiation therapy, 3 had some form of operation, 3 a combination of operation and radiation therapy, 2 excision and bone grafting and in 2 a diagnosis of sarcoma had been made and amputation advised. Three of the 40 patients died from incidental disease, 1 seven years after the operation. In the remaining, not only a cure but a good functional result was obtained. The conclusion was therefore reached that massive resection and excision by curettage followed by cauterization and filling of the resultant cavity with autogenous bone constitutes a safe procedure in properly selected cases.

A more radical surgical approach is recommended also by Mandl and Dwek.²⁰ These authors observed 2 cases of giant cell tumor of bone in which curettage was followed by the appearance of osteogenic sarcoma without the administration of roentgen therapy. In 1 case curettage was performed for a condition which roentgenographically was diagnosed as osteitis fibrosa of the tibia. The microscopic study indicated the presence of a giant cell tumor.

Three years later an osteogenic sarcoma developed and an amputation had to be done. In the second case a curettage for a giant cell tumor of the tibia was followed within a few months by a recurrence which proved to be osteogenic sarcoma. Because of this possible incompleteness of the curettage, Mandl and Dwek²⁰ recommended a more thorough excision or resection with insertion of a sliding bone graft.

Our series contains 2 cases in which the sarcomatous change developed following surgical procedures. In one case three surgical interventions were followed by roentgen therapy and an osteogenic sarcoma was noted seven years later. In the other case the malignant degeneration followed curettement with grafting of bone chips. This latter patient was subsequently treated with roentgen therapy and a good result was obtained persisting now for more than three years.

CASE VII. S. L., white male, was first seen at Harper Hospital on June 27, 1925, at the age of twenty-four years.

In the late fall of 1924 the patient noticed a swelling in the region of the upper third of the tibia.

A roentgen examination made on June 27, 1925 revealed a benign giant cell tumor of the right upper tibia (Fig. 13*A*).

From June, 1925, to September, 1927, the patient had two curettements at other institutions.

On September 10, 1927, a third curettement was done at Harper Hospital and the attending surgeon at this time used bismuth paste to fill the bone cavity.

The microscopic report was that of benign giant cell tumor of bone (Fig. 14*A*).

On September 26, 1927, the patient was referred for deep roentgen therapy because of the persistent recurrence of the lesion. A preliminary roentgenogram showed the bismuth paste completely filling the bone cavity (Fig. 13*B*).

From September 26, 1927, to April 5, 1928,

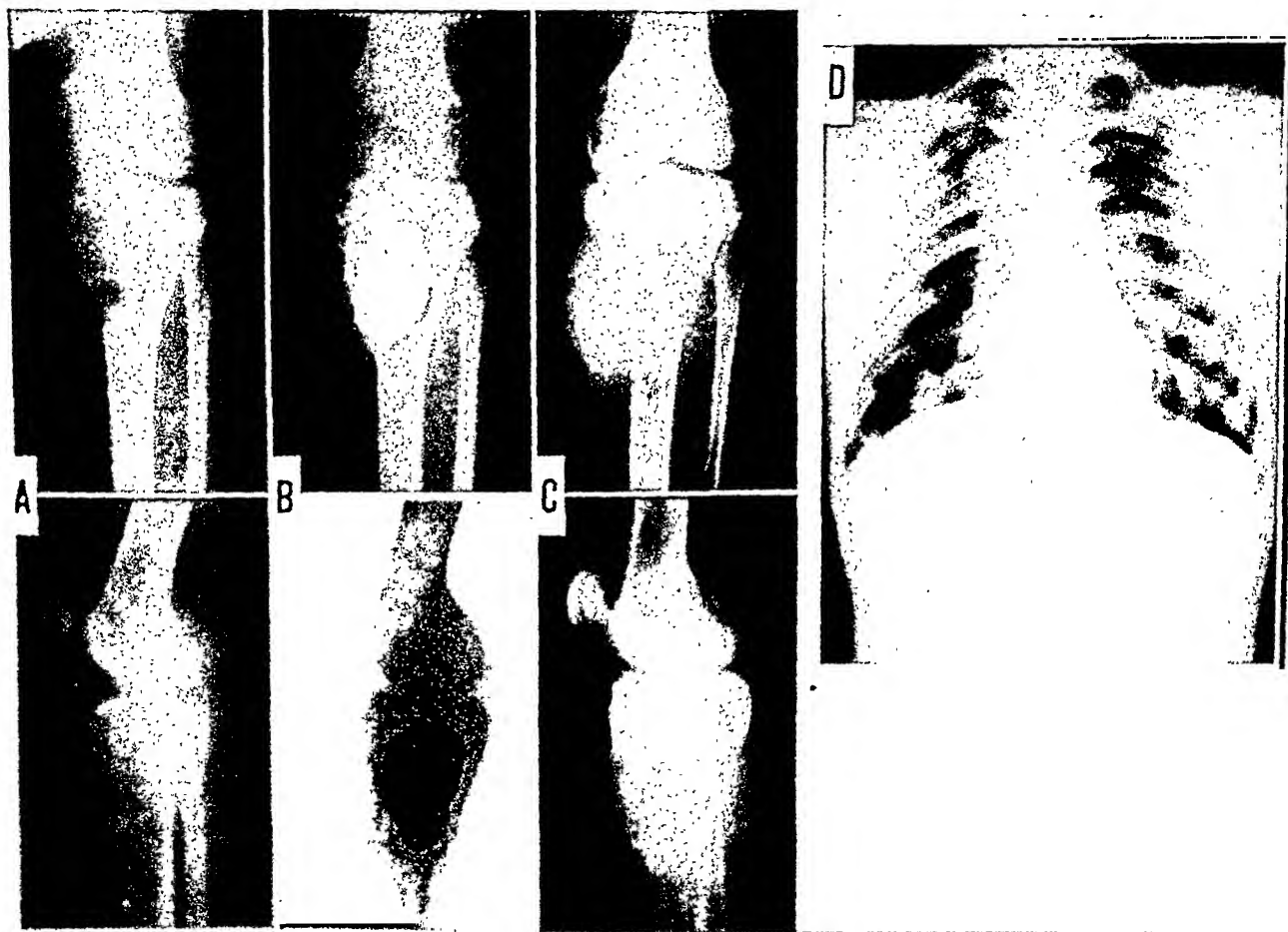


FIG. 13. CASE VII. *A*, benign giant cell tumor of the upper third of the right tibia; *B*, two years later, bismuth paste filling the bone cavity; *C*, seven years later, showing malignant degeneration; *D*, metastases to lungs.

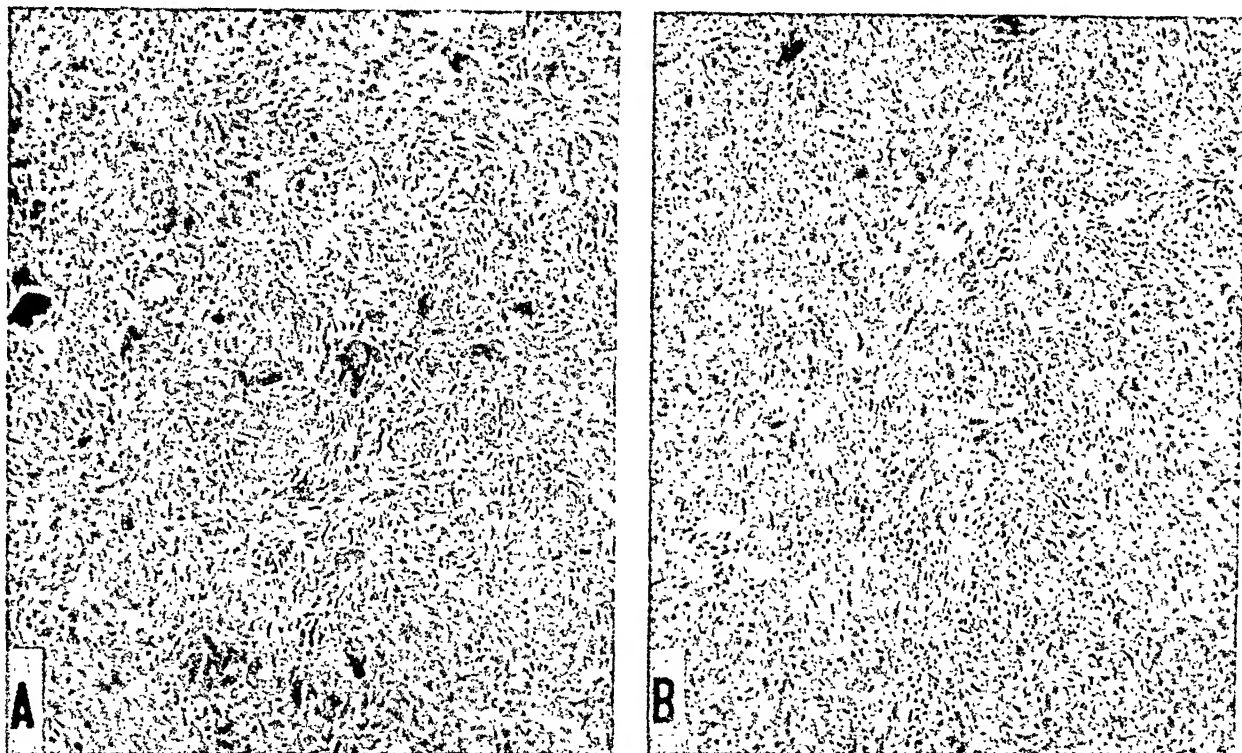


FIG. 14. Case VII. *A*, benign giant cell tumor of bone; photomicrograph of lesion shown in Figure 13*A*; *B*, osteogenic sarcoma; photomicrograph of lesion shown in Figure 13*C*.

the patient received five series of deep roentgen therapy. The factors were: 200 kv., 1 mm. Cu and 1 mm. Al filters; half-value layer of 1.8 mm. Cu and an intensity of 20 r/min. The initial tumor dose amounted to 90 per cent SUD, two opposite portals being used for cross-firing. The subsequent tumor doses were gradually reduced down to 50 per cent SUD at the fifth series.

The patient completely recovered and felt well until the spring of 1932 when he noticed a slight swelling at the site of the original tumor of the right tibia. On July 21, 1932, he fell and suffered a fracture through the upper end of the right tibia. A roentgen examination at this time revealed changes suggestive of a malignant degeneration of the former benign giant cell tumor complicated by a pathologic fracture (Fig. 13*C*).

On August 29, 1932, the tumor area was curetted for the fourth time. Simultaneously a parathyroidectomy was performed on the assumption that benign giant cell tumor of bone represents a solitary lesion of a Recklinghausen's disease incidental to hyperparathyroidism.

The microscopic examination of the tissue curetted from the tumor area showed "rapidly growing and markedly anaplastic polymorphous cell sarcoma" (Fig. 14*B*).

Soon after the operation metastases developed in the lungs (Fig. 13*D*) and the patient died in January, 1933.

CASE VIII. E. M. S., white female, aged thirty-seven, was first admitted to Harper Hospital on April 8, 1944.

The patient stated that on March 19, 1942, she tripped over a bag of grass seed and fell fracturing her left upper femur. She was taken to another hospital where she stayed for over three months. Traction was applied for six weeks and a body cast for another seven weeks. Then a brace was supplied and the patient was allowed to walk with the aid of crutches.

A roentgen examination at the time of admission to Harper Hospital revealed the presence of a multilocular cystic lesion in the upper end of the left femoral shaft, suggestive of benign giant cell tumor of bone (Fig. 15*A*).

On April 10, 1944, an operation was performed. An incision was made through the lateral aspect of the involved part of the upper femur and a window cut in the greatly thinned cortex of the bone. A moderate quantity of orange colored fluid was released exposing an irregular cavity about 3 inches long and 1½ inches in diameter, which was thought to be a simple bone cyst. The cavity was completely filled with bone chips removed from the left anterior iliac crest.

The microscopic examination indicated "bone cyst with giant cells" (Fig. 16*A*).

Subsequent roentgen study made on June 7, 1944, showed a very satisfactory operative result (Fig. 15*B*).

Additional checkup roentgenograms were taken at intervals of two to three months. The good result continued until May 31, 1945.

At this latter examination a definite expansion of the involved part of the femoral shaft was noted with a rather diffuse area of bone destruction suggestive of malignant metaplasia (Fig. 15*C*).

On July 16, 1945, a second operation was performed. The involved area of the left femoral shaft was explored and thoroughly curetted.

The microscopic report at this time was that of an osteolytic sarcoma of bone with a few giant cells (Fig. 16*B*).

Because of the above pathologic findings radiation therapy was recommended.

From July 30 to December 19, 1945, the patient received three series of supervoltage roentgen therapy with a technique as practiced in the osteolytic type of sarcoma of the bone. The factors were 500 kv. (constant), 7 mm. Cu, 3 mm. Al and 3 mm. celluloid as filters; half-value layer of 9 mm. Cu and an intensity of 20 r/min. Three portals of entry were used for cross-firing, one portal being treated per day with a full dose. The tumor dose for the three series amounted to 130 per cent, 110 per cent and 90 per cent SUD respectively.

Subsequent checkup roentgenograms revealed a satisfactory result. At the present time the patient is walking normally and there is a good reossification of the bone (Fig. 15*D*).

SUMMARY AND CONCLUSIONS

During a period of twenty-five years (1923 to 1947, inclusive) a series of seventy-

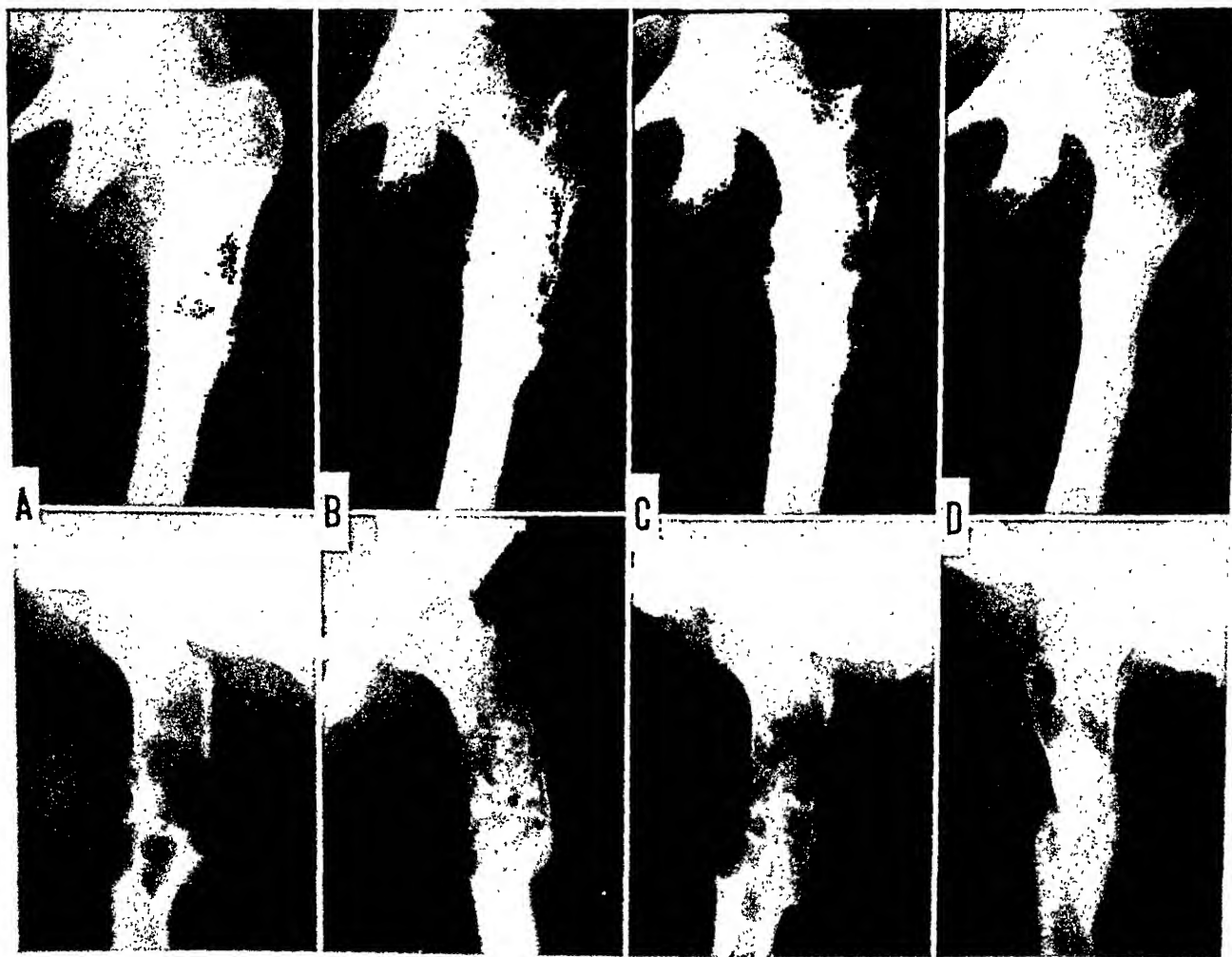


FIG. 15. Case VIII. *A*, multilocular cyst of the upper end of the left femur; *B*, after curettage and filling of cavity with bone chips; *C*, one year later, showing malignant metaplasia; *D*, five years later (three years after roentgen therapy) showing satisfactory result.

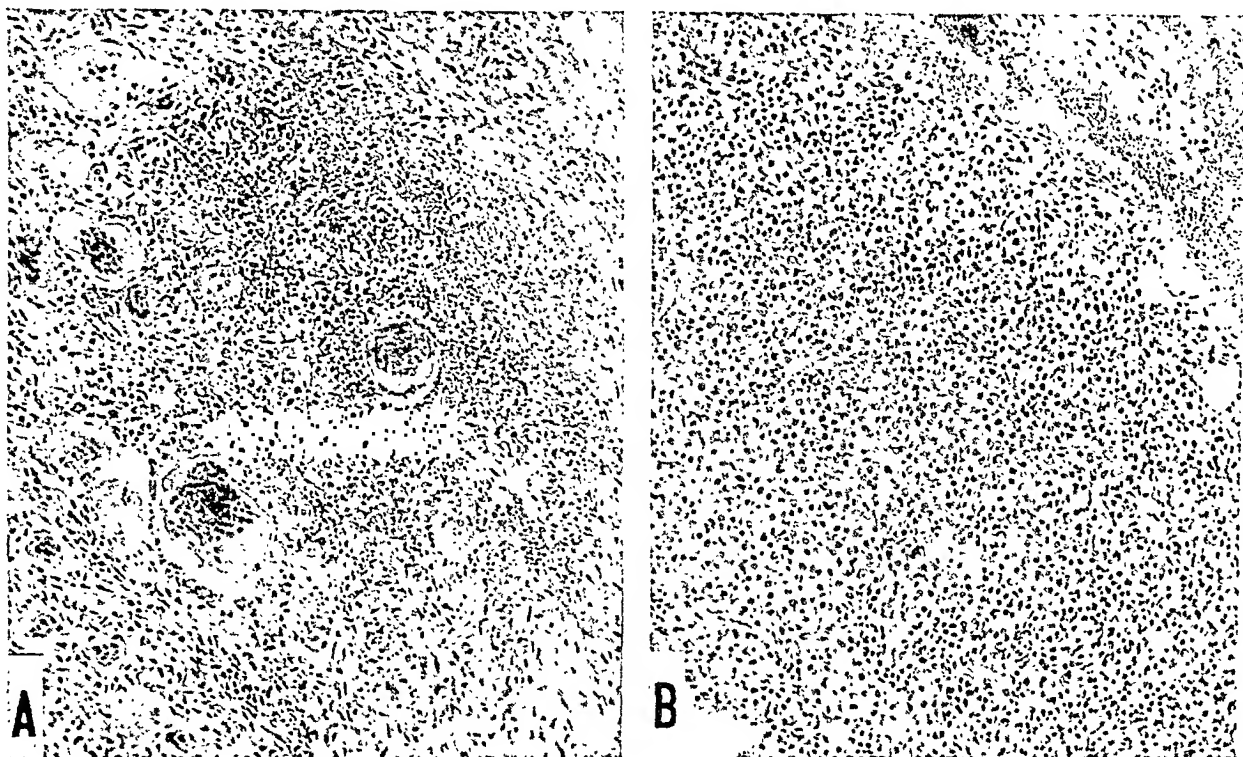


FIG. 16. Case VIII. *A*, bone cyst with giant cells; photomicrograph of lesion shown in Figure 15*A*; *B*, malignant metaplasia; photomicrograph of lesion shown in Figure 15*C*.

seven cases of benign giant cell tumor of bone were treated at Harper Hospital, Detroit, mostly by roentgen therapy. Five of the cases are known to be dead, three from incidental disease and two as a result of subsequent sarcomatous change of the benign giant cell tumor. Five cases are untraced, one of which had a malignant degeneration of the benign giant cell tumor. In an additional four cases a sarcomatous change of the benign giant cell tumor developed but after further treatment, either by surgery or irradiation, a satisfactory final result was obtained.

The seven cases in which the malignant degeneration occurred are presented in detail. They represented 9 per cent of the total of seventy-seven cases of the series.

In four cases the malignant degeneration was noted after routine roentgen therapy. However, in one the sarcomatous neoplasia was observed before the contemplated series of treatments were concluded so that the lesion was probably malignant from the beginning. In another, the roentgen dose given was so small that its significance can almost certainly be disregarded.

In the remaining two cases repeated pathologic fractures complicated the picture.

In one case the malignant degeneration apparently was spontaneous.

In two cases the sarcomatous change developed following surgical procedures. In one of these three surgical interventions were followed by roentgen therapy and an osteogenic sarcoma was noted seven years later. In the other case the malignant metaplasia followed curettage with filling of the cavity with bone chips.

An eighth case is included in which fibrosarcoma of the soft tissues and sternum developed eighteen years after gross over-irradiation for thymic enlargement.

Thus it may be said that in the enumerated cases the malignant degeneration resulted: (1) spontaneously; (2) following repeated surgery and irradiation; (3) following roentgen therapy alone; (4) following surgery alone when bone chips were used to fill the bone cavity.

The conclusion is drawn that the malignant degeneration of the giant cell tumor of bone occurs in a limited number of cases (10-15 per cent) as a natural sequence of

events unaffected by the type of treatment given.

Department of Radiology
Harper Hospital
Detroit 1, Mich.

REFERENCES

1. ANDERSEN, S. R. Malignancy of giant cell tumors. *Acta radiol.*, 1945, 26, 11-35.
2. BRUNSWIG, A. Observations on changes occurring at benign giant cell tumor sites several years following treatment by conservative measures. *Am. J. Roentgenol. & Rad. Therapy*, 1938, 40, 817-827.
3. CAHAN, W. G., WOODARD, H. Q., HIGINBOTHAM, N. L., STEWART, F. W., and COLEY, B. L. Sarcoma arising in irradiated bone. *Cancer*, 1948, 1, 3-29.
4. CODMAN, E. A. Treatment of giant cell tumors about the knee; study of 153 cases collected by the Registry of Bone Sarcoma of the American College of Surgeons. *Surg., Gynec. & Obst.*, 1937, 64, 485-496.
5. COLEY, B. L., and HIGINBOTHAM, N. L. Surgical treatment of giant cell tumor. *Ann. Surg.*, 1936, 103, 821-835; also Coley, B. L., and Higinbotham, N. L. Giant-cell tumor of bone. *J. Bone & Joint Surg.*, 1938, 20, 870-884.
6. COLEY, W. B. Malignant changes in so-called benign giant-cell tumor. *Am. J. Surg.*, 1935, 28, 768-820.
7. DOUB, H. P., HARTMAN, F. W., and MITCHELL, C. L. Immediate and end-results of radiation therapy in certain benign bone tumors. *Radiology*, 1938, 30, 420-436.
8. DYKE, S. C. Metastasis of "benign" giant-cell tumour of bone (osteoclastoma). *J. Path. & Bact.*, 1931, 34, 259-263.
9. EVANS, W. A., and LEUCUTIA, T. Value of roentgen-ray therapy in primary malignant tumors and benign giant cell tumor of bone. *Am. J. Roentgenol. & Rad. Therapy*, 1928, 20, 393-339.
10. FRANCISCO, C. B., PUSITZ, M. E., and GERUNDO, M. Malignant degeneration of a benign bone cyst? *Arch. Surg.*, 1936, 32, 669-678.
11. GERSHON-COHEN, J. Giant-cell tumors; radiation therapy and late results. *Radiology*, 1943, 41, 261-267.
12. GETTLER, A. O. Personal communication to Dr. H. S. Martland.²¹
13. HAGGAER, G. E., and HARE, H. F. Combined roentgen radiation and surgical treatment of large benign giant cell tumors of bone. *Ann. Surg.*, 1946, 124, 228-244.
14. HATCHER, C. H. Development of sarcoma in bone subjected to roentgen or radium irradiation. *J. Bone & Joint Surg.*, 1945, 27, 179-195.
15. JAFFE, H. L., LICHTENSTEIN, L., and PORTIS, R. B. Giant cell tumor of bone; its pathologic appearance, grading, supposed variants and treatment. *Arch. Path.*, 1940, 30, 993-1031.
16. JAFFE, H. L. Giant cell tumor of bone; problems of differential diagnosis. *Bull. Hosp. Joint Dis.*, 1944, 5, 84-91.
17. KILGORE, A. R., and ABBOTT, L. C. Sarcoma following benign bone lesions. *West. J. Surg.*, 1938, 46, 348-354.
18. LEUCUTIA, T., WITWER, E. R., and BELANGER, G. Late Results in benign giant-cell tumor of bone obtained by radiation therapy. *Radiology*, 1941, 37, 1-17.
19. MACGUIRE, C. J., and McWHORTER, J. E. Sarcoma of bone; analysis of 50 cases. *Arch. Surg.*, 1924, 9, 545.
20. MANDL, F., and DWEK, J. An appeal for a more radical attitude in the treatment of bone cysts and giant cell tumors. *J. Internat. Coll. Surgeons*, 1946, 9, 79-98.
21. MARTLAND, H. S. Occurrence of malignancy in radioactive persons. *Am. J. Cancer*, 1931, 15, 2435-2516.
22. MEYERDING, H. W. Benign and malignant giant-cell tumors of bone; diagnosis and result of treatment. *J.A.M.A.*, 1941, 117, 1849-1855.
23. MEYERDING, H. W. Treatment of benign giant-cell tumors by resection or excision and bone grafting. *J. Bone & Joint Surg.*, 1945, 27, 196-206.
24. NØRGAARD, F. Development of fibrosarcoma as a result of intra-articular injection of radium chloride for therapeutic purposes; new form of radium poisoning in human beings. *Am. J. Cancer*, 1939, 37, 329-342.
25. PEIRCE, C. B. Giant-cell bone tumor; consideration of the morphology of this neoplasm, the response to surgical and radiation therapy, and report in detail of two apparently malignant cases. *Am. J. Roentgenol. & Rad. Therapy*, 1932, 28, 167-188.
26. PEIRCE, C. B., and LAMPE, I. Giant cell bone tumor; further observations on treatment. *J.A.M.A.*, 1936, 107, 1867-1871.
27. SIMMONS, C. C. Malignant changes occurring in benign giant cell tumors of bone. *Surg., Gynec. & Obst.*, 1931, 53, 469-478.
28. STEWART, F. W., COLEY, B. L., and FARROW, J. H. Malignant giant cell tumor of bone. *Am. J. Path.*, 1938, 14, 515-536.
29. STONE, W. S., and EWING, JAMES. An unusual alteration in the natural history of a giant cell tumor of bone. *Arch. Surg.*, 1923, 7, 280-296.
30. UEHlinger, E., and SCHÜRCH, O. Experimental production of sarcoma with radium and mesothorium. *Schweiz. med. Wchnschr.*, 1938, 68, 860-861; abstr. in *Radiology*, 1939, 32, 383.
31. WITWER, E. R., and LEUCUTIA, T. Late sequelae of divergent biologic skin effects produced by roentgen irradiation with varying voltages. *Radiology*, 1940, 34, 24-27.

THE VALUE OF UPRIGHT ROENTGENOGRAMS OF THE MATERNAL PELVIS AT OR NEAR TERM WITH PARTICULAR REFERENCE TO PLACENTA PRAEVIA*

By H. R. CREWS, M.D., A. O. HAMPTON, M.D., and J. P. MOORE, M.D.

WASHINGTON, D. C.

THE purpose of this paper is to emphasize the value of upright roentgenograms of the maternal pelvis recommended by Ball and Golden.¹ They observed that in normal cephalic presentations the fetal head dips into the pelvic inlet and occupies the mid-coronal and mid-sagittal planes of the inlet during the last trimester of

from the central position or prevent it from entering the pelvic inlet (Fig. 2, 3 and 4).

The relation of the size of the fetal head to the pelvic inlet is usually apparent by inspection of the films since both structures are in more or less the same plane.

For the past three years all pregnant patients at Garfield Memorial Hospital

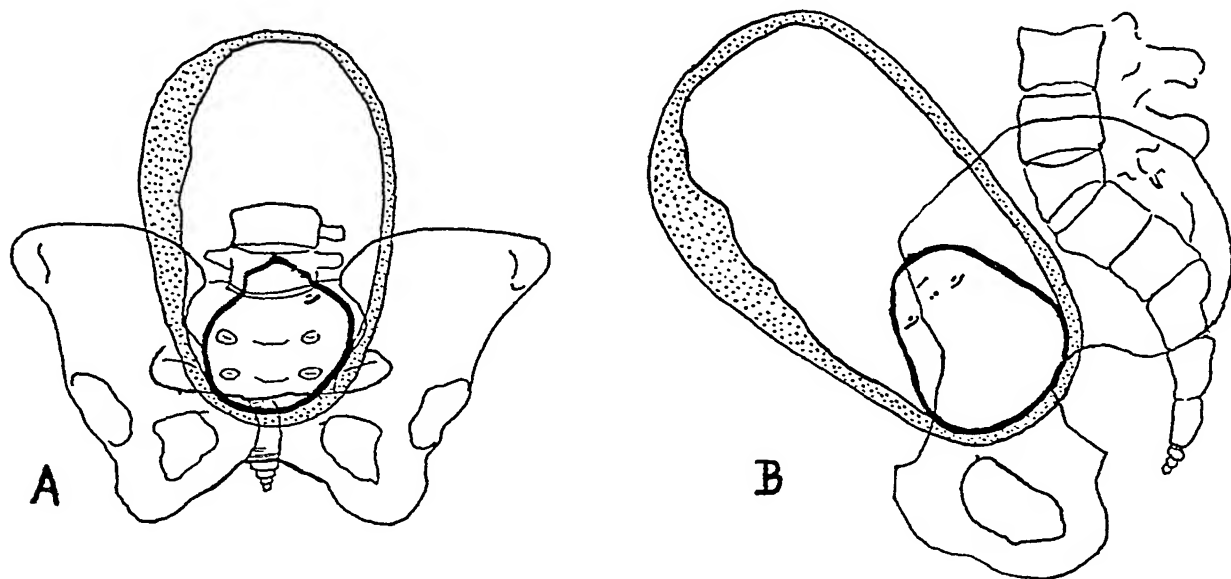


FIG. 1. Sketches of anteroposterior and lateral views of the maternal pelvis with patient upright. Normal findings. (A) The fetal head is centrally located. (B) The fetal head is centrally located and is engaged. The head is equidistant from the anterior margin of the first sacral segment and from the posterior margin of the symphysis.

pregnancy when the mother is upright (Fig. 1). However, with the mother horizontal the fetal head shifts in relation to the pelvic inlet with change in position of the maternal pelvis. Any pelvic mass in addition to placenta praevia, either marginal or central, may displace the fetal head

have been examined in the following manner:

1. Lateral and posteroanterior roentgenograms are made with the patient horizontal and with the central ray directed to the center of the pregnant uterus. These films are made at a target-film distance of 30 inches with a movable grid and the shortest possible exposure time. Pillows may be placed under the thighs and chest

¹ Ball, R. P., and Golden, R. Roentgenographic obstetrical pelvicephalometry in the erect posture. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 731-741.

* From the Radiological Clinic of Drs. Groover, Christie and Merritt, Garfield Memorial Hospital, Washington, D. C.

to make the patient more comfortable and instructions given for the patient to take several deep breaths before exposure to minimize motion of the patient and fetus.

roentgenograms also demonstrate fetal structure to great advantage. This examination may be made with the patient upright, if an upright movable grid is avail-

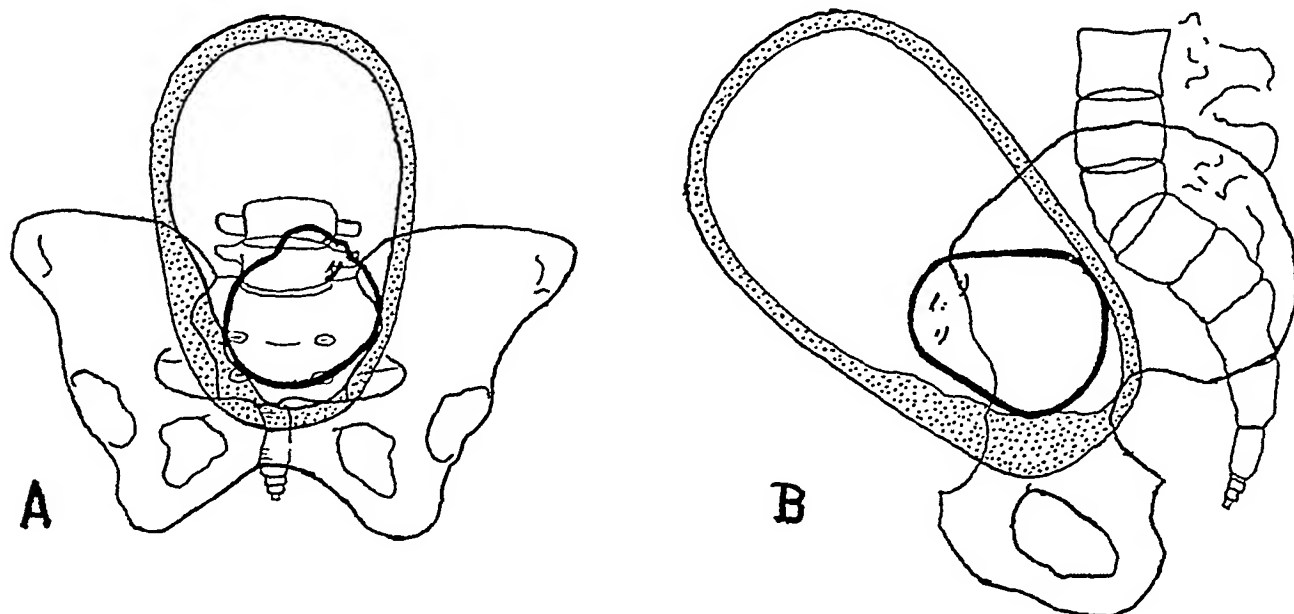


FIG. 2. Sketches with patient upright. Marginal placenta praevia. (A) The fetal head is displaced laterally. (B) The fetal head is displaced posteriorly by the placenta which is located on the anterior wall of the uterus. Contrast medium in the bladder is of value when the placenta is located anteriorly.

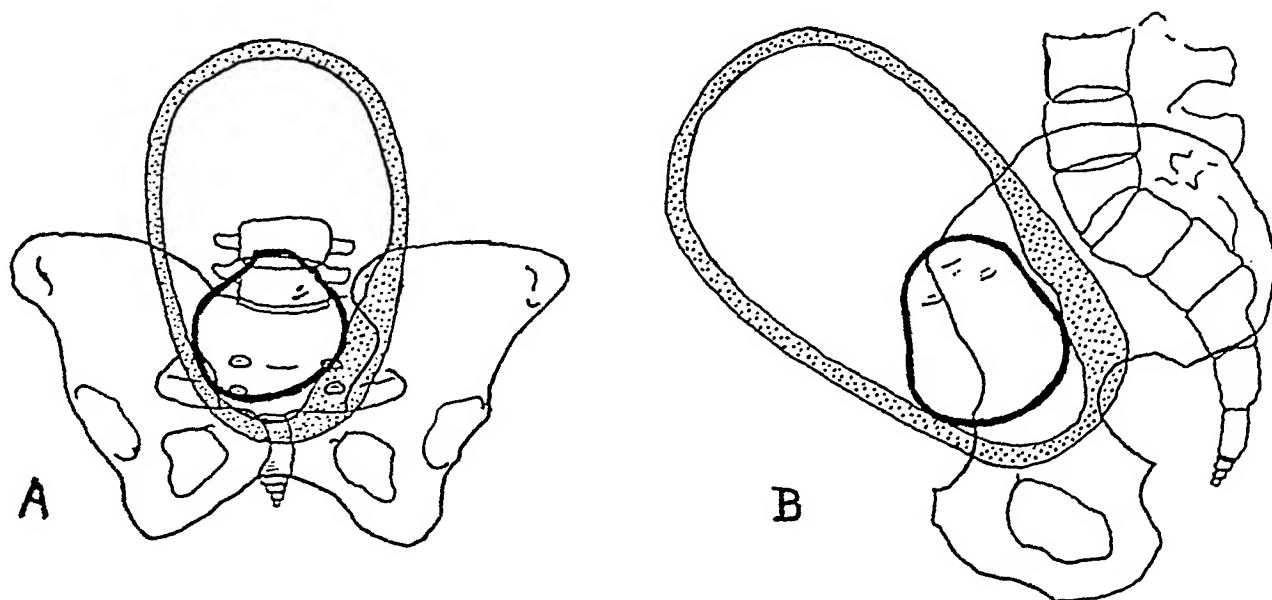


FIG. 3. Sketches with patient upright. Marginal placenta praevia. (A) The fetal head is displaced laterally. (B) The fetal head is displaced anteriorly by the placenta which is located on the posterior wall of the uterus. Contrast medium in the rectum is of value when the placenta is located posteriorly.

Such films provide adequate visualization of the upper three-fourths of the uterus and usually serve to visualize the placenta or a portion of it. Oblique views of the uterus may occasionally be necessary to definitely outline the placenta. These soft tissue

able, since it is more comfortable for the patient than the horizontal position.

2. Lateral and anteroposterior roentgenograms are made with the patient upright and with the central ray directed through the pelvis 1 inch above the level of

the greater trochanter of the femur. These films may be made at any distance with a movable or stationary grid and provide adequate visualization of the maternal pelvis and fetal head rather than soft tissue detail.

Thirty cases suspected of having placenta praevia have been examined in the Department of Radiology during the past three years. Twelve of these patients had abnormal findings indicative of placenta praevia and these findings were subse-

uted to marginal location of the placenta (Fig. 6, 7, 8 and 9).

3. Non-visualization of the placenta and upward displacement of the head in the absence of cephalopelvic disproportion is attributed to a centrally located placenta.

4. Failure of the head to enter or center upon the inlet may be due to disproportion of the fetal head in relation to the inlet and should be apparent from the measurement of the size of the head and the inlet.

5. Visualization of the placenta in the

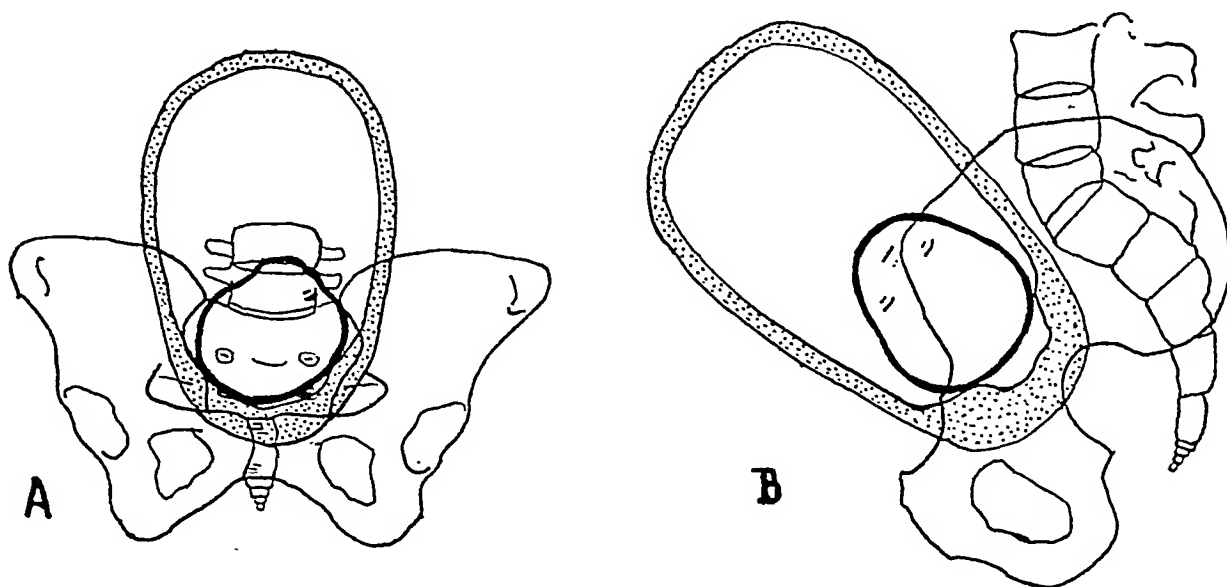


FIG. 4. Sketches with patient upright. Central placenta praevia. (A) The fetal head is centrally located but appears high. (B) The fetal head is centrally located but is not engaged. Contrast medium in the bladder and rectum of value when the placenta is centrally located.

quently confirmed at time of operation. Two patients had findings indicative of cephalopelvic disproportion. From these 30 cases several observations have been made which verify those first reported by Ball and Golden. These observations may be grouped as follows:

1. If the placenta is visualized with certainty in the upper portion of the uterus and the head enters or centers upon the pelvic inlet with the patient upright, there is no evidence of placenta praevia or cephalopelvic disproportion (Fig. 5).

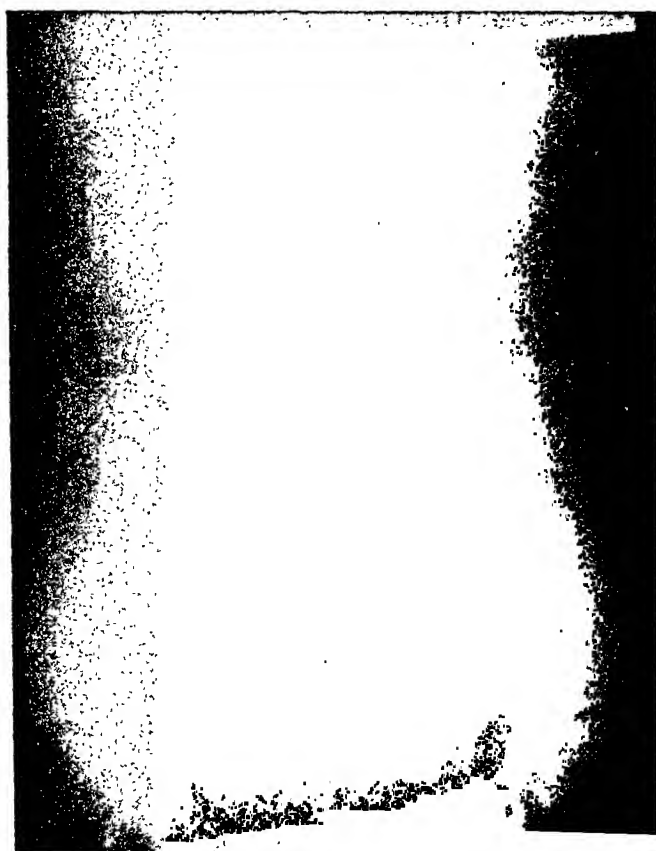
2. If the placenta is visualized in the mid or lower portion of the uterus and the head is displaced in relation to the inlet with the patient upright, the displacement is attrib-

uted to marginal location of the placenta (Fig. 6, 7, 8 and 9).

upper portion of the uterus with displacement of the head in relation to the inlet and without evidence of disproportion is indicative of a pelvic tumor.

In one patient the placenta was visualized in the upper portion of the uterus and yet the fetal head failed to engage with the patient upright in spite of more than adequate inlet measurements. A normal delivery followed. For this we have no explanation but in our experience its occurrence is rare.

6. Indefinite visualization of the placenta and upward displacement of the fetal head in the absence of cephalopelvic disproportion may be due to delayed rupture of the membranes. In such a case the fluid-



A



B



C

FIG. 5. Upright films. Normal pregnancy. (A) The fetal head is centrally located. (B) The fetal head is displaced posteriorly by the bladder which is filled with sodium iodide. (C) The fetal head is centrally located. The bladder is empty.

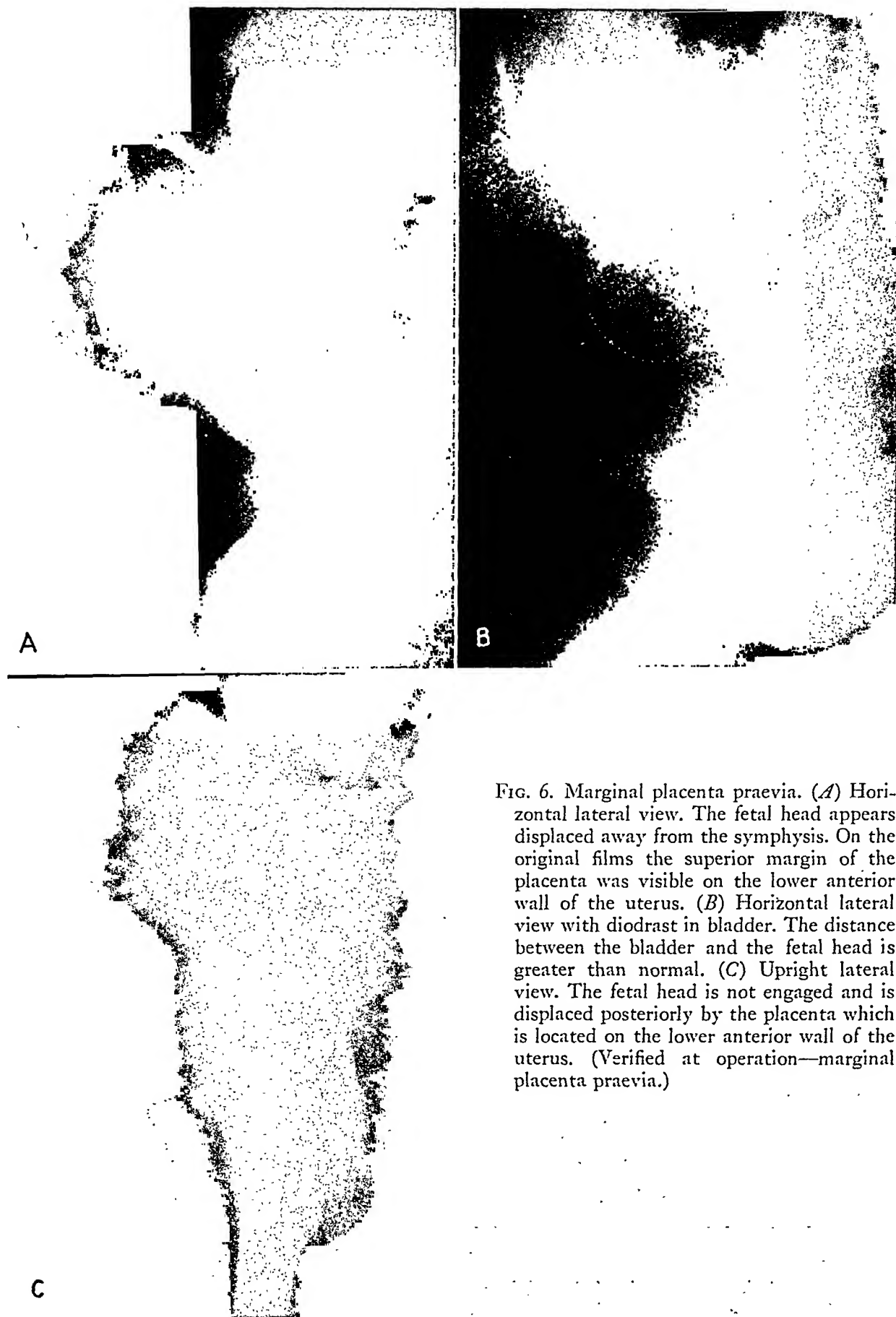


FIG. 6. Marginal placenta praevia. (A) Horizontal lateral view. The fetal head appears displaced away from the symphysis. On the original films the superior margin of the placenta was visible on the lower anterior wall of the uterus. (B) Horizontal lateral view with diodrast in bladder. The distance between the bladder and the fetal head is greater than normal. (C) Upright lateral view. The fetal head is not engaged and is displaced posteriorly by the placenta which is located on the lower anterior wall of the uterus. (Verified at operation—marginal placenta praevia.)

FIG. 8. Marginal placenta praevia. (A) Horizontal lateral view of uterus. The superior margin of the placenta is visible on the posterior wall of the uterus. (B) Upright lateral view of the pelvis. The fetal head is displaced anteriorly by the placenta which is located posteriorly. The distance between the fetal head and the gas shadow in the rectum represents the width of the placenta. (Verified.)



filled amniotic sac protruding through the cervix occupies the position usually occupied by the head and may be confused with a centrally located placenta praevia. A

or anteriorly respectively and for these reasons the bladder and rectum should be emptied before examination. While a cystogram, with air or opaque medium (Fig. 6),



FIG. 7. Marginal placenta praevia. (A) Horizontal lateral view of uterus. The superior margin of the placenta is visible on the posterior wall of the uterus. (B) Upright lateral view of the pelvis. The fetal head is displaced anteriorly by the placenta which is located posteriorly. (Verified.)

rectal examination should readily differentiate between the two conditions.

7. A distended bladder (Fig. 5) or rectum may displace the fetal head posteriorly

and air or barium in the rectum (Fig. 8) may aid in the localization of the placenta by the abnormal width between the fetal head and the bladder or rectum, their use



FIG. 6. Marginal placenta praevia. (A) Upright anteroposterior view of pelvis. The fetal head appears high and is displaced laterally. (B) Upright lateral view of pelvis. The fetal head is displaced anteriorly and does not engage. The placenta is located posteriorly and laterally. (Verified.)

A

B

FIG. 8

A

B

FIG. 9

should be restricted to those cases examined in the upright position. Since the fetal head shifts when the patient is horizontal and may rise completely out of the pelvis, the normal distance between the fetal head and bladder and rectum may thus be interpreted as an abnormal finding attributed to a pelvic tumor.

Due to marked variation in size of placenta it is not safe to exclude a marginal placenta praevia by simple visualization of this structure in the body of the uterus. Upright films are necessary to determine the inferior margin of the placenta (Fig. 7 and 8).

We have found that the angle of inclina-

tion of the pelvic inlet has little or no effect on the centering of the fetal head. The fetal head has centered even in those multipara with pendulous abdomens and in primipara before so-called lightening has occurred. Were these patients examined in the upright position by the obstetricians, their observations would doubtless confirm the roentgen findings.

This exceedingly simple examination also eliminates the necessity of elaborate measurements of the fetal head and the pelvic inlet.

1835 Eye St., N.W.
Washington 6, D. C.



CHONDROMA OF THE LARYNX

REPORT OF A CASE

By MAXWELL D. RYAN, M.D.

Surgeon, Department of Otolaryngology

and

JUDAH ZIZMOR, M.D.

Assistant Radiologist, Department of Radiology

New York Eye and Ear Infirmary

NEW YORK, NEW YORK

CHONDROMA of the larynx is rare. Moore¹ cited 53 cases from the world literature up to 1925, after excluding 9 other cases as unproved. By 1944, 32 more cases were reported, bringing the total number to 85. The literature on chondroma of the larynx was reviewed and the subject was comprehensively discussed in the papers by Moore in 1925 and again by McCall, Dupertuis and Gardiner² in 1944. Another detailed review would therefore be superfluous at this time. It is the purpose of this paper to add another case to the literature on this unusual condition.

CASE REPORT

The patient, a white male, aged fifty-five, native of the United States, was admitted to the New York Eye and Ear Infirmary on February 5, 1947, with complaint of persistent hoarseness for the past three years. In recent months he had difficulty in breathing.

Past medical and family history was essentially negative.



FIG. 1. Lateral view of larynx showing a partly calcified and ossified chondroma arising from the posterior wall of the larynx at the level of the cricoid.

Physical examination revealed an elderly white male not appearing ill. His voice was hoarse. Examination of the ears, nose and pharynx showed no significant pathologic findings. Laryngeal examination revealed a subglottic mass involving the left vocal cord, restricting its mobility and partly occluding the glottis on phonation. Examination of the lungs, heart and abdomen showed no abnormality.



FIG. 2. Anteroposterior tomogram of chondroma of the larynx arising at the level of the cricoid and growing upward to impinge on the laryngeal ventricle.

Blood pressure was 118/80. The clinical impression was left subglottic mass.

On February 6, 1947, roentgen examination of the larynx, including the lateral projection and anteroposterior tomography, revealed a large round soft tissue mass arising from the posterior wall of the upper trachea and cricoid and extending upward to impinge on the vocal cords causing partial obliteration of the airway. These findings suggested a calcifying and ossifying soft tissue tumor, probably an osteochondroma of the larynx (Fig. 1 and 2).

rounding structures. Speech is interfered with and the passage of air through the larynx is obstructed in varying degrees. Hoarseness, dyspnea and cough are common. Chondromas usually grow inward, obstructing the airway and impairing laryngeal function. Outward growing chondromas such as those from the outer surface of the body of the thyroid cartilage, manifest themselves as palpable tumors or produce pain and dysphagia. Superimposed

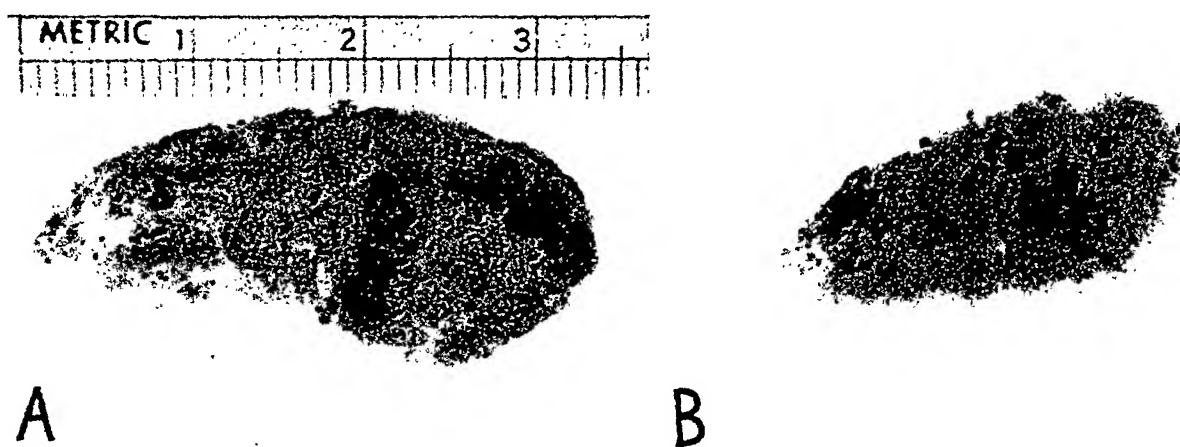


FIG. 3. (A) Surgical specimen of chondroma of the larynx, showing calcareous surface spots. (B) Roentgenogram of surgical specimen.

On February 6 a laryngeal fissure operation was performed under local anesthesia. A large bone-hard mass covered by mucous membrane extended from the left wing of the thyroid cartilage, posteriorly, to the posterior signet of the cricoid and upper ring of the trachea. It was dissected free and removed in toto (Fig. 3).

Postoperatively the patient's course was uneventful. He was discharged to his home on the fourth postoperative day.

Pathological Report. Microscopic section shows islands of hyaline cartilage separated by spaces with red blood cells. At some points in decalcified sections there is bone formation. This process is essentially a chondroma without evidence of malignant change.

Diagnosis. Chondroma of the larynx.

CRITERIA FOR DIAGNOSIS

Early diagnosis of chondroma of the larynx is difficult because it is slow growing and its symptoms and physical signs appear late. The symptoms arise from impairment of laryngeal function and pressure on sur-

respiratory infection may precipitate severe dyspnea and stridor in a patient whose symptoms had been mild. Emergency treatment with tracheotomy may then be required.

Laryngoscopy reveals a sessile or occasionally a pedunculated laryngeal mass whose mucosal blood vessels are prominent. Fig³ stresses this feature as well as the hardness of the mass, as indicating the diagnosis of chondroma.

The most frequent sites of origin of chondroma are the posterior segment of the cricoid, the thyroid cartilage, the epiglottis, and the arytenoids.

Roentgenography is of increasing value in the diagnosis of laryngeal tumors. The lateral projection is helpful in profiling the extent of a tumor above and below the glottis. In recent years tomography (planigraphy) has been used increasingly for delineating laryngeal tumors at different depths in the anteroposterior projection. If

the tumor contains irregular calcium or bone deposits, the roentgenological diagnosis of calcifying or ossifying chondroma is made easy. Virchow⁴ has stated, however, that the process of ossification in a chondroma requires twenty to thirty years. Of 30 cases reviewed by McCall *et al.*² since 1925, a mass or calcifying tumor was described in the roentgen report in each of 6 cases; in 3 the roentgen diagnosis was specifically chondroma.

Jackson and Jackson⁵ stress the importance of direct laryngoscopy, palpation and biopsy. If a tumor is hard to palpation with a forceps a chondroma is suspected. The hardness of this tumor often makes excision of tissue for biopsy difficult.

DIFFERENTIAL DIAGNOSIS

Chondroma of the larynx, because of its rarity, is seldom suspected as the cause of laryngeal symptoms. Nonspecific laryngitis, polyps, tuberculosis and malignancy, being more common, are usually suspected as the cause of hoarseness, dyspnea and cough. The dyspnea associated with chondroma, when complicated by upper respiratory infection, may simulate bronchial and cardiac asthma, croup or aspirated foreign body.

PATHOGENESIS

Chondroma usually arises as localized overgrowth from laryngeal cartilage. It is usually not encapsulated and does not shell out. More rarely an encapsulated type of chondroma arises from cartilage rest cells. This type shells out easily, permitting the larynx to resume its normal shape and function. Chondromas often contain irregular

calcifications and show characteristic calcareous surface spots (Fig. 3). Chondromas may ossify (osteochondroma); show myxomatous change (chondromyxoma); or undergo malignant degeneration (chondrosarcoma).

TREATMENT

The only effective treatment is surgical. Roentgen and radium therapy are of no value. With a small tumor direct laryngoscopic removal may be possible. Laryngeal fissure is usually the operation of choice. For extensive tumors, or if the tumor has recurred after laryngeal fissure operations, total laryngectomy may be necessary.

SUMMARY

A case of chondroma of the larynx has been reported. The diagnosis was based initially on a characteristic roentgenographic appearance of the tumor. Surgical findings and pathological examination confirmed the roentgenographic diagnosis.

New York Eye and Ear Infirmary
New York, N. Y.

REFERENCES

1. MOORE, I. Cartilaginous tumours of the larynx. *J. Laryng. & Otol.*, 1925, 40, 9-14; 84-109; 145-164.
2. MCCALL, J. W., DUPERTUIS, S. M., and GARDINER, F. S. Chondroma of the larynx; review of the literature and report of 2 cases. *Laryngoscope*, 1944, 54, 1-17.
3. FIGI, F. A. Chondroma of the larynx. *Ann. Otol., Rhin. & Laryng.*, 1932, 41, 369-386.
4. Quoted from paper by Moore.¹
5. JACKSON, C., and JACKSON, C. L. Diseases and Injuries of the Larynx. Macmillan Co., New York, 1942, pp. 401-407.



NEUTRON AND ROENTGEN-RAY EFFECTS ON PROTEIN CONTENT OF RAT INTESTINE

By M. H. ROSS, V.M.D., and J. O. ELY, Ph.D.

From The Biochemical Research Foundation

NEWARK, DELAWARE

STUDIES of the effects of penetrating radiation^{4,5} on the chemical constituents of the cells of the crypts of Lieberkühn indicated a marked decrease in amounts of desoxyribonucleic acid, ribose nucleic acid, inorganic ash, and structural protein. The present investigations which extend these cytochemical studies indicate that changes in the concentration of total protein in the cells of the crypts of Lieberkühn and in total nitrogen in the intestinal mucosa also occur after irradiation with roentgen rays and with neutrons.

EXPERIMENTAL

White rats of the Brooklyn strain previously studied for nucleic acid changes following irradiation were used for the estimation of total protein. Ten rats received 600 r, roentgen radiation, 9 received 56 n, neutron radiation, 10 received 100 n, and 10 received 200 n. Each irradiated rat was paired with a control rat of the same weight. All were killed twenty-four hours after completion of irradiation. Sections of duodenum were taken from all the rats and were fixed in a 3:1 alcohol-acetic acid mixture.

Each duodenum from an irradiated animal was embedded together with the duodenum from a control animal of the same weight. Both tissues were sectioned at 3 microns with the same stroke of the microtome knife in order to have sections of similar thicknesses.

TYROSINE AND TRYPTOPHANE DETERMINATION

Pairs of successive sections from each block were mounted on opposite ends of a glass slide. One pair was completely treated with Millon reagent; the other, a control pair, was treated in a similar

manner except for omission of treatment with NO_2 ; the latter served as "blanks."

The sections were mounted in glycerin, sealed with paraffin, and photographed according to the techniques described previously³ with the ultraviolet microscope at 3654 Å. Since the spectrum of nucleic acid with its maximum at 2600 Å overlaps that of protein with its maximum at 2800 Å, and the absorption by protein is small when compared to that of nucleic acid, this makes it difficult or impossible to determine protein content by absorption at 2800 Å. Pollister and Ris⁸ have shown that the maximum absorption of tyrosine and tryptophane, as constituents of protein, can be shifted from the region of 2800 Å to 3600 Å by treatment with the Millon reagents. For this reason, 3654 Å was chosen.

Photographs were taken of at least three different fields of the crypts of Lieberkühn in each of the four sections and of at least one from an area of the slide where no tissue was present to obtain the "background density." All photographs were taken on the same strip of film under identical conditions of light, exposure, and development. In the determination of the amount of absorption of the tyrosine and tryptophane portions of the protein in the tissue sections, density of the image on the film was determined by the use of a micro-densitometer.⁴ At least thirty areas of each frame were read. The estimated value of the extinction coefficient of the tissue tyrosine and tryptophane was obtained by taking the average of the logarithmic values of the readings after correction for background and the blank.

A significant decrease in the tyrosine and tryptophane absorption at 3654 Å in the crypts of Lieberkühn was found twenty-four hours after the rats received 600 r.

The results (Table I) show that the average extinction coefficient decreased in irradiated tissues and was 28.9 per cent less than that of the controls.

Six of the 9 animals which received a neutron dose of 56 n showed a decreased amount of absorption by tyrosine and tryptophane at 3654 Å; 1 showed no change; 2 showed an increase. The average decrease

TABLE I

EFFECT OF NEUTRON AND ROENTGEN IRRADIATION ON THE TYROSINE AND TRYPTOPHANE CONTENT OF THE CRYPTS OF LIEBERKÜHN

Irradiation	No. of Animals	Average Extinction Coefficient		Per Cent Decrease Extinction Coefficient
		Control	Irradiated	
600 r	10	0.368	0.262	28.8
56 n	9	0.373	0.340	8.8
100 n	10	0.454	0.342	24.7
200 n	10	0.356	0.208	41.6

in extinction coefficients (Table I) in irradiated tissue was 9.0 per cent less than that of the controls.

A significant and marked decrease in absorption at 3654 Å, indicating decreased amounts of tyrosine and tryptophane, was found in the crypts of Lieberkühn twenty-four hours after the animals had received 100 n or 200 n. The decrease was consistent for all of the 20 irradiated rats. The average extinction coefficient decreased 24.6 per cent and 41.4 per cent respectively (Table I) for those rats given 100 n and 200 n. The data indicate a greater decrease in tyrosine and in tryptophane content in those animals given 200 n than in those given either of the two smaller doses of neutron radiation.

ARGININE DETERMINATION

A modification of the Serra method⁹ was used on pairs of tissues sectioned at 7 microns. After deparaffination, the sections were coated with a thin layer of collodion and the alpha-naphthol hypobromite reaction was carried out at near

freezing temperatures by use of dry ice. The tissues were then mounted in glycerin and the coverslip sealed to the slide with paraffin. Visual examination of the section was made through a microscope equipped with a green filter.

Sections of duodenum showed a decrease in arginine content in 8 of the 10 animals given 100 n. In all of the 10 animals given 200 n there was a greater decrease than in those given 100 n. All of the crypts of Lieberkühn of the animals which had received 600 r showed a decrease.

NITROGEN

Fifty white rats, approximately 125 grams each, were divided equally into five groups of 10 animals and treated in the following manner:

Group 1—untreated controls—food ad lib.
Group 2—irradiated with 200 n—killed 24 hours after completion of irradiation.

Group 3—diet restricted for 24 hours to the amount of food eaten by group 2—killed at the end of this period.

Group 4—irradiated with 200 n—killed 48 hours after completion of irradiation.

Group 5—diet restricted for 48 hours to the amount of food eaten by group 4—killed at the end of this period.

All of the rats were decapitated. The entire small intestine from the stomach to the cecum was removed and opened longitudinally to expose the mucosa. The intestine was thoroughly washed in cold running water and placed in a heavy walled conical 50 milliliter centrifuge tube. A stainless steel spatula was forcibly applied with a crushing rotary motion to the intestine to free the mucosa from the muscularis. Three to five minutes was necessary to strip the mucosa from the muscularis. About 20 cc. of acetone was added to the macerate and the crushing procedure repeated. After the mucosa-free muscularis was discarded, the mucosa was washed three times with acetone. After each centrifugation, the super-

natant fluid containing acetone was discarded. The mucosa was dried for five hours at 40° C. Microchemical determinations for nitrogen⁶ were made on the white, finely divided powder.

A significant decrease was found in the total dry weight of the mucosa from the irradiated animals which had been sacrificed twenty-four hours after irradiation and a greater decrease in those sacrificed forty-eight hours after irradiation (Table II). There was no significant change in the

results indicate that the decrease in total protein content of the cells of the crypts of Lieberkühn is also dependent upon the dose; the greater the amount of irradiation, the less total protein present. No timed series of the cytochemical determinations of protein was made, but the results of the timed series of total mucosal nitrogen determinations indicate that these changes are progressive.

Numerous nitrogenous substances other than protein are part of the total nitrogen

TABLE II

NITROGEN CONTENT OF ACETONE-DRIED INTESTINAL MUCOSA FROM NEUTRON IRRADIATED AND FOOD RESTRICTED RATS

No. of Rats	Treatment	Average Nitrogen in Dry Mucosa	Average Dry Weight of Intestinal Mucosa	Calculated Amount N ₂ in Dry Mucosa	Average Loss of N ₂
		per cent	mg.	mg.	
10	Untreated	13.50	438	59.1	
10	Irradiated 200 n. Killed 24 hr. later	13.27	288	38.2	35%
10	Unirradiated. Diet restricted to amount of food consumed by group 2	13.25	442	58.6	
10	Irradiated 200 n. Killed 48 hr. later	12.93	123	15.9	73%
10	Unirradiated. Diet restricted to amount of food consumed by group 4	13.32	438	58.4	

values found for nitrogen in the intestinal mucosa of those animals whose food had been restricted. Slight decrease in percentage of nitrogen was noted in animals which had received 200 n and had been killed twenty-four hours after irradiation; a somewhat greater decrease was found in those animals which had been killed forty-eight hours after irradiation (Table II). A reduction was found in the calculated total nitrogen of the mucosa of the small intestine of animals which had been irradiated while there was no reduction in the calculated total nitrogen in unirradiated animals whose food had been restricted (Table II).

DISCUSSION

The decrease in nucleic acid content was found to be dependent upon the dose as well as upon the length of time which had elapsed after irradiation.^{1,2} The present

in tissue, but the greater part of the nitrogen present is that of protein. Nucleic acid and protein have been shown to decrease after irradiation. Differences in the rate of decrease of these substances or of other nitrogenous materials may produce a change in percentage of nitrogen in the dry tissue even though there is no qualitative change in either the nucleic acid, protein, or other nitrogen bearing compounds. The very small change observed after irradiation in percentage of nitrogen may mean there is a difference in the ratio of these cellular constituents to one another.

Not only are there fewer cells after irradiation but presumably each cell contains less material. Cell size and nuclear size are considerably increased twenty-four hours after roentgen or neutron irradiation.^{4,6} The decrease in the amount of total dried mucosa indicates, however, that there is

not only a decrease in total amount of protein, nucleic acid, etc., but that the existing substances in each cell are diluted still further by increased water concentration or by acetone soluble substances.

Irradiated animals have been found to eat less than non-irradiated control animals. In order to determine whether a reduction in the food intake may lead to a reduction in the amount of tissue protein, non-irradiated fasted animals were studied. Since no change was found in the amount of any of these substances after food restriction, the decrease in protein content of the intestinal mucosa cannot be explained by lowered food consumption and hence seems to be a phenomenon brought about by irradiation.

The dose of roentgen rays required to produce the same degree of change in the protein content in the cells of the crypts of Lieberkühn is about six times greater than that of neutrons. The decrease in protein twenty-four hours after irradiation with 600 r was found to be only slightly greater than the decrease after 100 n.

Some evidence of a close relationship between ribonucleic acid activity and protein synthesis has been offered.¹ A parallel relationship was found in this study, where a decreased amount of nucleic acid was found to be associated with decreased amounts of protein after irradiation. These results do not indicate whether the synthesis of nucleic acid and protein are interdependent.

Denaturation of proteins,¹⁰ changes in the phenol groups of tyrosine and tryptophane,^{11,12} inactivation of enzymes,² and depolymerization of nucleic acid^{13,14} when pure solutions were irradiated with roentgen rays have been described. Mazia⁷ has shown that pepsin in the dry form is inactivated with small doses of roentgen radiation. It has been shown that these substances in solution can be protected¹¹ by the addition, prior to irradiation, of numerous other compounds. Whether the decrease in nucleic acid and protein content represent a direct effect of irradiation or an

indirect effect is not known. In a chain of interdependent reactions, however, it would seem that the nucleic acid and protein changes are closer to the primary effect than the strictly morphological changes previously reported in the literature.

SUMMARY

A reduction in the amounts of tyrosine, tryptophane, arginine and nitrogen, which are important constituents of protein, is evidence of a reduction in the amount of protein after neutron and roentgen irradiation.

Cytochemical determinations of the total protein content in tissue sections was estimated through the study of the tyrosine and tryptophane ultraviolet absorption at the wavelength 3654 Å. The tyrosine and tryptophane content was markedly decreased in the crypts of Lieberkühn twenty-four hours after 600 r total body roentgen irradiation, but there was no significant change in the tyrosine and tryptophane content of the crypts of Lieberkühn twenty-four hours after 56 n total body neutron irradiation. A considerable decrease in the tyrosine and tryptophane content of the crypts of Lieberkühn was found twenty-four hours after 100 n or 200 n total body irradiation respectively.

The arginine content was found to decrease twenty-four hours after 600 r or 200 n total body irradiation.

The percentage of nitrogen was not markedly changed in the acetone dried intestinal mucosa in irradiated or non-irradiated fasted animals. The amount of acetone-dried intestinal mucosa was significantly changed after twenty-four and forty-eight hours in those animals irradiated with 200 n, but was not changed in those non-irradiated animals whose food had been restricted for the same periods of time. The calculated total nitrogen for the acetone-dried intestinal mucosa was found to be greatly decreased twenty-four and forty-eight hours respectively after 200 n neutron radiation, but there was no sig-

nificant reduction in non-irradiated fasted animals.

Biochemical Research Foundation
Newark, Delaware

REFERENCES

1. CASPERSSON, T. The relations between nucleic acid and protein synthesis. In: Symposia of the Society for Experimental Biology. I. Nucleic Acid. University Press, Cambridge, 1947, pp. 127-149.
2. DALE, W. M. The effect of x-rays on the conjugated protein d-amino-acid oxidase. *Biochem. J.*, 1942, 36, 80-85.
3. ELY, J. O., and ROSS, M. H. A method of ultraviolet photomicrography. *J. Franklin Inst.*, 1948, 246, 87-91.
4. ELY, J. O., and ROSS, M. H. Nucleic acid content in intestines of rats after x-radiation. *J. Cancer Research*, 1948, 8, 285-294.
5. ELY, J. O., and ROSS, M. H. Nucleic acid content in intestines of rats after neutron radiation. *J. Cancer Research*, 1948, 11, 607-610.
6. MA, T. S., and ZUZAGA, T. Micro-Kjeldahi determination of nitrogen. *Ind. Eng. Chem., Anal. Ed.*, 1942, 14, 280-282.
7. MAZIA, D. Inactivation of enzyme-substrate films by small doses of x-rays. *Proc. Nat. Acad. Sc.*, 1948, 34, 328-336.
8. POLLISTER, A. W., and RIS, H. Nucleoprotein determination in cytological preparations. In: Cold Spring Harbor Symposia on Quantitative Biology. Long Island, New York, 1947, 12, 147-157.
9. SERRA, J. A. Improvements in the histochemical arginine reaction and the interpretation of this reaction. *Portugaliae acta biologica* 1, Fasc. 1, 1944, pp. 1-7.
10. SPIEGEL-ADOLF, M. Effects of ultraviolet rays, radium and x-rays on proteins. *Arch. Path.*, 1931, 12, 533-542.
11. STENSTROM, W., and LOHMANN, A. Effect of roentgen radiation on solutions of tyrosine and cystine. *J. Biol. Chem.*, 1928, 79, 673-678.
12. STENSTROM, W., and LOHMANN, A. Effect of roentgen radiation on solutions of tyrosine, phenol, and tryptophane. *Radiology*, 1931, 17, 432-434.
13. TAYLOR, B., GREENSTEIN, J. P., and HOLLAENDER, A. Effects of x-radiation on thymus nucleic acid. *Science*, 1947, 105, 263-264.
14. TAYLOR, B., GREENSTEIN, J. P., and HOLLAENDER, A. Effects of x-radiation on sodium thymus nucleate. *Arch. Biochem.*, 1948, 16, 19-36.



NEUTRON EFFECTS ON ALKALINE PHOSPHATASE OF RAT INTESTINE

By M. H. ROSS, V.M.D., and J. O. ELY, Ph.D.

Biochemical Research Foundation

NEWARK, DELAWARE

A RAPID and significant change was reported^{2,3,9} in the concentration of ribonucleic acid, desoxyribonucleic acid, protein and ash in the crypts of Lieberkühn of the rat as a result of neutron and roentgen irradiation. These changes in nucleic acid and protein suggested a need for further studies of the derangement of nucleoprotein metabolism in irradiated animals.

Krugelis^{6,7} showed in cytochemical determinations that alkaline phosphatase was closely associated with nucleic acid. Since alkaline phosphatase is involved in the metabolism of phosphoesters, any change in the activity of phosphatase after irradiation would indicate that there might be changes in the metabolism of phosphoric-acid-bearing substances, especially of ribonucleic acid and desoxyribonucleic acid.

EXPERIMENTAL

Ten male albino rats of the Brooklyn strain, weighing 150 grams each, were irradiated with a neutron dose of 200 n. Each irradiated animal was paired with an unirradiated control animal of the same weight. Twenty-four hours after irradiation the irradiated and the control rats were decapitated and sections of duodenum were taken and fixed in cold 95 per cent alcohol. Each of the sections of duodenum from an irradiated animal was embedded in paraffin with the section from an unirradiated control animal. Both tissues were sectioned at 6 μ with the same stroke of the microtome knife.

Alkaline phosphatase was determined according to the Gomori method⁴ on pairs of successive sections from each block incubated in different substrates. The phosphomonoesters used for substrates were beta glycerophosphate, yeast adenylic acid, and yeast guanylic acid; the phosphodies-

ters used were enzyme depolymerized desoxyribonucleic acid⁶, ribonucleic acid, and diphenyl phosphate. The sections were incubated from one-half to twenty-four hours in solutions of the various substrates containing magnesium and calcium salts until the optimal reaction was obtained for each substrate at pH 9.0 with veronal buffer and pH 7.0 with acetate buffer. Since the controls and irradiated sections were of the same thickness, mounted on the same slide and treated alike, any difference in the amount of cobalt sulfide would be due to differences in the amount of phosphatase enzyme or its activity. Sections were also incubated at pH 9.0 and 7.0 in a medium that contained no phosphoester and then treated with the cobalt and ammonium sulfide

Essentially the same phosphomonoesterase reaction was obtained at pH 9.0 whether the beta-glycerophosphate, adenylic acid or guanylic acid was used, but consistent differences were noted between control and experimental tissues. The cobalt sulfide blanks showed no apparent "staining," while control tissues incubated in a medium containing a phosphoester showed slight but definite "staining" in the cells of the crypts and somewhat greater "staining" in their nucleoli. Sections from irradiated animals with a phosphomonoester substrate showed deeper "staining" in the cytoplasm, nucleus and especially in the nucleolus, than those from controls. The reaction in the crypts of Lieberkühn was not as strong as the reaction in the cytoplasm, nucleus and nucleolus of the villi.

With the phosphodiester diphenyl phosphate, desoxyribonucleic acid or ribonucleic acid at pH 9.0 the activity in the nucleus and nucleolus of the cells of the crypts of Lieberkühn in tissues from irradiated ani-

mals was stronger than the very weak reaction found in the control sections. There was also a stronger cytoplasmic reaction in sections from irradiated animals than from controls, but the "staining" was uneven. With the phosphomonoesters the reaction in the crypts of the control sections was similar to the reaction obtained in the control specimens.

With all of these substrates no difference could be found in the cells of the villi between the controls and experimental animals.

At pH 7.0 no differences were observed between tissues from irradiated and from control animals. No differences were observed in size or intensity of "staining" of the Golgi apparatus which reacts at this pH.

DISCUSSION

Radioactive phosphorus turnover has been shown by Scott¹⁰ to be decreased after roentgen and neutron irradiation. Hevesy⁵ showed that the turnover of desoxyribonucleic acid and phosphatide phosphorus of the nucleus was also decreased. Scott's results give no indication that the catabolic processes involving nucleic acid were altered but only that the amount of phosphorus utilized was decreased. A considerable decrease in the number of cells of the crypts of Lieberkühn had been found twenty-four hours after neutron irradiation of rats³ and also in the amount of nucleic acid, protein and inorganic constituents. The cells which remained were enlarged and contained larger nuclei and nucleoli. The activity of the alkaline phosphatase in such cells now has been found to be increased. In the light of the findings that nucleic acid was reduced in amount after irradiation, it would seem that the reduced turnover of radioactive phosphorus was related to the reduced synthesis of nucleic acid or to the decrease in number of living cells.

The complex phosphorus-bearing products of cell destruction and cell injury, which may be the result of irradiation, are probably acted upon by alkaline phosphatase and are reduced to simpler substances.

The progressive decrease in nucleic acid for the first few days after irradiation together with the loss of phosphorus would indicate that the increased phosphatase activity is dependent upon such cell damage and is of a catabolic nature. This increase in activity would result in a loss of phosphorus from the cell¹ and may be the cause of the increase in inorganic phosphorus found in blood after irradiation.¹¹ At pH 7.0, which is more nearly that of the pH of living tissue, however, the phosphatase reactions in control and irradiated tissues were found to be similar.

An increase in phosphatase activity has been noted by Wachstein¹¹ in livers of rats after dietary protein depletion. It has been shown in previous studies³ that there is a protein depletion after roentgen and neutron irradiation. In the present study a decrease in phosphatase activity was found. While different techniques were used to produce a protein depleted condition, the results are similar. The relation, if any, however, between protein depletion and the increased phosphatase activity is not evident.

SUMMARY

The effect of neutron irradiation on the alkaline phosphatase of the rat duodenum was investigated. An increase in alkaline phosphatase activity at pH 9.0 was found in the nuclei and nucleoli in the cells of the crypts of Lieberkühn when beta-glycerophosphate, desoxyribonucleic acid, ribonucleic acid, adenylic acid, guanylic acid, or diphenyl phosphate was used as the source of organic phosphorus.

No difference could be observed between the phosphatase activity of the cells in the villi of the duodenum from irradiated and from non-irradiated animals.

No difference in phosphatase activity at pH 7.0 was noted in any of the parts of the duodenum of irradiated and non-irradiated animals with any of these substrates.

REFERENCES

1. DUNLAP, C. E. Effects of radiation on the blood and hemopoietic tissues, including the spleen, the thymus and the lymph nodes. *Arch. Path.*, 1942, 34, 562-608.
2. ELY, J. O., and ROSS, M. H. Nucleic acid content in intestines of rats after X-radiation. *Cancer Research*, 1948, 8, 285-294.
3. ELY, J. O., and ROSS, M. H. Nucleic acid content in intestines of rats after neutron radiation. *Cancer Research*, 1948, 11, 607-610.
4. GOMORI, G. Microtechnical demonstration of phosphatase in tissue sections. *Proc. Soc. Exper. Biol. & Med.*, 1939, 42, 23-26.
5. HEVESY, G. Effect of X-rays on the rate of turnover of phosphatides. *Nature*, 1946, 158, 268.
6. KRUGELIS, E. J. Distribution and properties of intracellular alkaline phosphatases. *Biol. Bull.*, 1946, 90, 220-233.
7. NICKERSON, W. J., KRUGELIS, E. J., and ANDRÉSEN, N. Localization of alkaline phosphatase in yeast. *Nature*, 1948, 162, 192-193.
8. ROSS, M. H., and ELY, J. O. Effect of large doses of neutrons on dogs. In: *Neutron Effects on Animals*. Staff of the Biochemical Research Foundation. Williams and Wilkins Company, Baltimore, 1947, pp. 160-169.
9. ROSS, M. H., and ELY, J. O. Neutron and roentgen-ray effects on protein content of rat intestine. *AM. J. ROENTGENOL. & RAD. THERAPY*, Nov., 1949, 62, 718-722.
10. SCOTT, K. G. A comparison of two levels of roentgen and neutron irradiation of normal and lymphomatous mice, using radiophosphorus as an indicator of cellular activity. *Radiology*, 1946, 46, 173-175.
11. WACHSTEIN, M. Influence of dietary deficiencies and various poisons on the histochemical distribution of phosphatase in the liver. *Arch. Path.*, 1945, 40, 57-67.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

TRAINING OF THE BLIND FOR DARK ROOM TECHNICIANS

By SHERWOOD MOORE, M.D.

Director of the Mallinckrodt Institute of Radiology

ST. LOUIS, MISSOURI

THE very best possible roentgen technique is only as good as the dark room processing of the films. The best roentgen technician can fail because of poor dark room technique. The methods of solving this problem have been many and varied. Every combination of personnel and method has been tried with almost universally poor results.

Having heard of a radiologist who employed a blind dark room technician a year or so ago, I reflected over that matter and recalled the times when I had to perform my own dark room work in emergencies. Frequently I did not take the trouble to turn on the red lights in the dark room, relying on the sense of feel and the time clock to process the negatives. Putting these two points together it seemed a desirable experiment to attempt the employment of blind individuals for this function of a roentgen department.

The local Bureau for the Blind was consulted and showed immediate interest. It placed three blind men in the laboratory in order to see if they could master the procedure. These three men were instructed by the senior roentgen-ray technician for a period of about a month. By that time they had acquired manual proficiency which justified attempting to use them under actual working conditions. A month's experience satisfied me that, if permission could be secured, they could be put on as permanent personnel. This has continued for the past seven months with extremely satisfactory results.

A word of explanation as to the conditions under which these blind technicians work. There are two dark rooms, one of the conventional type and the other finished with the automatic processing machine. The conventional dark room was designed for two dark room technicians, one to load and unload cassettes and hangers with his hands dry and the other to be at the solution tanks. They, of course, alternated. With the automatic machine one blind technician carries the entire load. In an eight hour day these three processed from 400 to 600 films per day.

As to results, the technical roentgenographic quality is of a high order. The roentgen-ray technicians are satisfied since their efforts are not nullified by careless dark room technique. They do not have to give any help in the dark room and indeed do not have to go into it. Their services are more important and in greater need outside of the dark room than they ever would be inside. Best of all, the blind men are happy. As one of them commented, "This is far better than making brooms." The success of this experiment was so satisfactory that it stimulated my interest in helping the blind and, second, in contributing something to other roentgenologists who, if they have sufficient dark room work, would find themselves much happier with this part of the activities cared for by a blind individual. These two considerations are the chief ones for bringing the matter to the notice of roentgenologists. Again, there is the hope that the

film industry and commercial photographic laboratories will take up this form of employment for those handicapped by loss of sight. Several outstanding radiologists were communicated with in the hope of arousing their interest. This met with some quite favorable reactions. I found out that the idea was not in the least original with me, that several roentgenologists had employed the blind with considerable success. Dr. Howard P. Doub, Editor of *Radiology*, called my attention to an editorial in that journal on this subject several years ago.

In the correspondence a good many objections to the employment of the blind were brought up. These are about as follows: Fear that the blind person would need considerable help, danger of transit to and from work, existing satisfactory methods of conducting the dark room, a volume of work too small to justify a dark room technician. Other objections may develop in the future. The experience so far leads to the belief that properly selected and trained individuals would eliminate all objections so far advanced except possibly that of small volume of work.

In the Mallinckrodt Institute of Radiology films are processed on the "time and temperature" method with thermostatic controlled solutions and the photographic method of film identification. These blind employees have no difficulty with any phase of the work even though with thermostatic control temperatures will vary, but the blind man can make a time correction with a Braille thermometer. The blind can vary time of development even where laboratories have to use ice for cooling. They keep the solutions at the correct level and will doubtless manage the "replenisher" system which is in process of being installed. Preparation of the chemical solutions does have to be done by the roentgen-ray technicians.

Additional advantages to employing the blind are that the roentgen-ray technicians are freed from the monotony and fatigue of dark room work, where their superior abilities are more or less wasted.

Success in employing blind dark room technicians depends upon the selection of suitable individuals who should be thoroughly trained in advance of embarking on the actual work. There are certain limita-

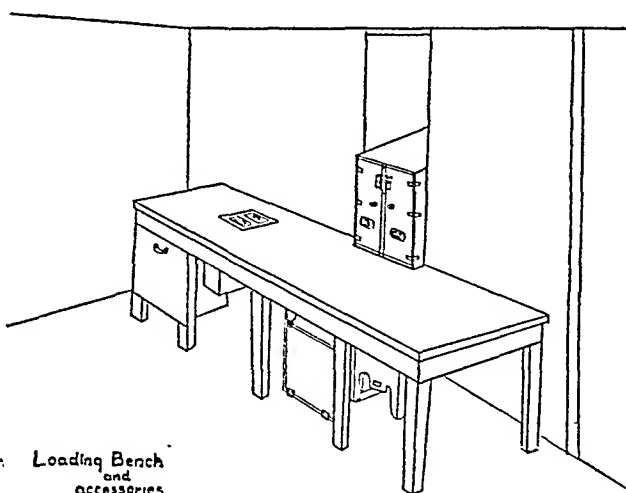


FIG. 1

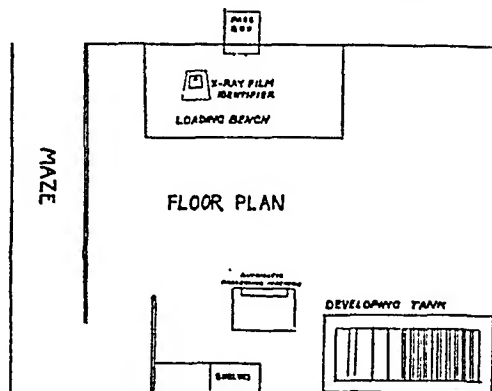
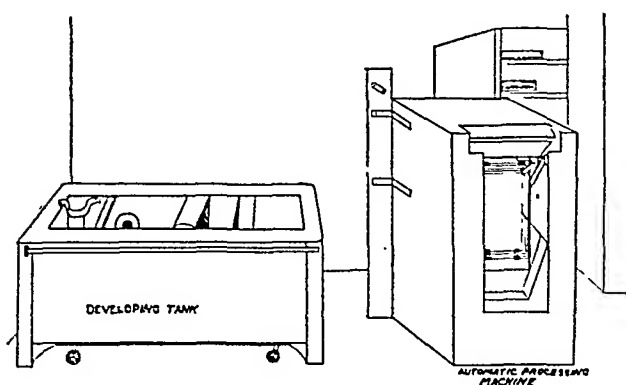


FIG. 2

tions in the selection of individuals for training. They should be able to go and come without aid and find their way about a roentgen department without help. They should be temperamentally equipped for

the training and the work. They should be given an aptitude test. They should be young enough to acquire, if they do not already possess it, manual dexterity. Either men or women can be trained (one girl has been trained). They should be conscientious and honest. The selection of individuals to be trained should be left to the state or federal agencies for the blind. These agencies have the facilities for giving the aptitude tests and find persons with the proper background and can help in the placement once the blind person has been trained.

Our success coupled with some applications for training were sufficient that a pilot dark room was set up with the necessary appliances for training. Training was restricted to those referred by the agencies mentioned above. (Figures 1 and 2 are black line drawings illustrating this pilot dark room.)

The trainees are instructed by the senior technician until they acquire such speed and dexterity that they can be entrusted with actual dark room work. The pilot dark room naturally is "dry." They are drilled with loading and unloading films from cassettes and loading and unloading hangers and hangettes until time studies measure their efficiency. When the speed of operation approaches that of a fully trained technician the training is continued under actual working conditions. Length of training will vary with the individual. Parenthetically, the blind employees can unload and load and place a film in solution as speedily as can a technician with sight. Training requires about two weeks in the pilot dark room after which they are transferred to the actual dark room to do the daily work.

The Federal Security Agency, Office of

Vocational Rehabilitation, and the Illinois Division of Vocational Rehabilitation and a representative from the Bureau for the Blind have investigated this training program and expressed the view that it has possibilities for a good livelihood for the blind. It is not and should not be a method of getting cheap help.

There is full realization that there are limited opportunities in departments of roentgenology. However, as a step toward training the blind for the film industry and commercial photography this training project may open a door for large opportunities.

In departments of roentgenology, if the photographic method of film identification is used, this can be easily done by the blind. Other methods of film identification present a real difficulty which, however, is not insurmountable. In the training plan for the blind those who learn to write before they have lost their vision are trained to write the name and date on a film before it is processed. Even if in a department of roentgenology film identification is a bar to the blind, their employment is well worth while to load and unload cassettes, hangers and hangettes.

The roentgen-ray industry has given whole hearted and generous support. They have amply supplied outdated film for "dry" training, hangers, cassettes and permission to reconstruct the loading end of the automatic machine. Because of this, the expense of training is reduced to a minimum. The only expense to the representative bureaus is that of travel, subsistence and housing for the trainees plus compensation for the roentgen-ray technician who gives the training on his own time.

510 S. Kingshighway Blvd.
St. Louis 10, Mo.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. *Foreign*

Collaborators: GÖSTA FORSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San Jose, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.; *Secretary:* H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio,

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fifty-first Annual Meeting: Jefferson Hotel, St. Louis, Mo., Sept. 26-29, 1950.

AMERICAN RADIUM SOCIETY

President: William S. MacComb, New York, N. Y.; *President-Elect:* Leland R. Cowan, Salt Lake City, Utah; *1st Vice-President:* James A. Corscaden, New York, N. Y.; *2nd Vice-President:* Douglas J. Roberts, Hartford, Conn.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: Charles L. Martin, Chairman, Dallas, Texas, A. N. Arneson, St. Louis, Mo., Maurice Lenz, New York, N. Y.

Program Committee: Leland R. Cowan, Chairman, Salt Lake City, Utah, Joseph Farrow, New York, N. Y., John L. Pool, New York, N. Y.

Publication Committee: Edward H. Skinner, Chairman, Kansas City, Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Education and Publicity Committee: James A. Corscaden, Chairman, New York, N. Y., John F. Hynes, Wilmington, Del., Grant H. Beckstrand, Los Angeles, Calif.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, Chairman, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: Gordon P. McNeer, Chairman, New York, N. Y., Gray H. Twombly, New York, N. Y., Theodore R. Miller, New York, N. Y.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., John E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: Biltmore Hotel, New York, N. Y., May 25-26, 1950.

E D I T O R I A L S

THE ANNUAL MEETING OF THE AMERICAN
ROENTGEN RAY SOCIETY

THE Fiftieth Annual Meeting of the American Roentgen Ray Society held in Cincinnati, Ohio, October 4 to 7, 1949, was outstanding in many respects. Held under the presidency of Dr. U. V. Portmann of Cleveland, Ohio, the Scientific Program was among the best that has been presented before the Society. On the opening day, following the call to order by the outgoing President, Dr. Lawrence Reynolds, and his presentation of the scientific awards, the Society was welcomed to Cincinnati by Dr. Raymond Walter, President of the University of Cincinnati, and in a very interesting address he sketched briefly the history of Cincinnati and the important part the city has played in the development of the Midwest.

The American Roentgen Ray Society always welcomes an opportunity to return to Cincinnati for its annual meeting; because it is so centrally located, it is accessible to all parts of the country and the facilities of the meeting place, the Netherland Plaza, are unsurpassed.

Dr. Portmann, after his installation as President, gave a very interesting address on "Therapeutic Radiology as a Specialty." In this he discussed the various aspects of therapeutic radiology, its present position within the framework of the radiological departments of hospitals and universities, and suggested some modification of the position of therapeutic radiology in the organization of radiological departments. Dr. Portmann's address will be published in full in a forthcoming issue of the JOURNAL.

Dr. Portmann and his Program Committee had arranged a splendid program which

was thoroughly enjoyed and from which all the members and guests profited. It is not necessary here to mention the various papers given for they will be published in future issues of the JOURNAL.

One of the highlights of the meeting was the Caldwell Lecture which occurred on Wednesday evening. The lecture was given by Dr. Stanley P. Reimann, Director of the Research Institute, Lankenau Hospital Philadelphia, and he discussed "The Differentiation of Cells and Tissues." In his brilliant talk Dr. Reimann called attention to the importance of the differentiation of cells and their concomitant and subsequent organization into tissues, parts and organs, and he stressed the fact that this is the very essence of a large part of biology and medicine and applications of such differentiation ramify into every nook and cranny of our daily thinking and work. These processes, he said, made us and our patients what we are; in fact, make all living things what they are. There has perhaps never been given before the Society a more fundamental and thought-provoking dissertation than that of Dr. Reimann.

This year's Scientific Exhibit may be favorably compared with the best at any of the previous meetings of the Society. To Dr. G. Allen Good and the members of his Scientific Exhibit Committee the Society owes its thanks. The Scientific Exhibit itself alone was worth a trip to Cincinnati and many of the scientific exhibits amplified and extended papers that were given in the scientific program. Elsewhere in this number of the JOURNAL is given a detailed account of the scientific exhibits shown and the awards given.

The Commercial Exhibits this year may also be accounted among the best that the Society has had and the Program Committee had quite properly set aside certain hours during the day for the members and guests to visit both the Scientific and Commercial Exhibits. These two exhibits are features of the annual meetings which are of such importance as to warrant this setting aside of specific hours for their inspection.

The day preceding the opening meeting was given over to the Annual Golf Tournament which was held at the Kenwood Country Club through the kindness and arrangement of the Local Committee. Competition for the Willis F. Manges Trophy was participated in by one of the largest groups of players of any tournament within recent years and the dinner following the golf tournament was perhaps the largest of any, certainly in a number of years. To the Chairman, Dr. Harold G. Reineke and his Local Committee, the Society expresses its very great appreciation not only for the arrangements for the annual golf tournament but for all of the other social functions, as well as the arrangements having to do with the various

phases of the scientific program.

The annual banquet which was held on Thursday evening was as usual one of the highlights of the social activities of this year's meeting. Approximately five hundred attended the banquet which was held in the beautiful Pavillon Caprice. Following the banquet the Local Committee had arranged a splendid floor show after which there was dancing.

At the meeting, the Ladies Committee, with Mrs. Harold G. Reineke as Chairman, had arranged a splendid program for the ladies, including interesting trips to the various places of historical interest and to the splendid art museums in Cincinnati.

The success of the meeting was brought about not only by the splendid planning of President Portmann and his Program Committee and the Local Committees on Arrangements, but also by the Netherland Plaza and its personnel in cooperation with the Convention Bureau by seeing that those attending were properly and pleasantly housed, and as might have been anticipated the meeting in Cincinnati proved to be an excellent one in every respect.



ARIAL WELLINGTON GEORGE

1882-1948

DR. ARIAL WELLINGTON GEORGE, one of the nation's pioneer radiologists whose research in roentgen diagnosis of diseases of the gastrointestinal tract, gall-bladder and spine had aided humanity throughout the world, died on December

In recognition of his application of the roentgen ray to medical diagnosis, the British Royal Society of Medicine selected him, in 1923, as one of the first Americans to receive the Sir James MacKenzie-Davidson Memorial Medal. Three years later he received an honorary Doctor of Science degree from Tufts College and an honorary Diploma in Medical Radiology and Electrology from the University of Cambridge, England.

He was a former teacher at the Tufts and the Harvard Medical Schools and he was the author of several books including "Surgical Lesions of the Gastro-intestinal Tract," "The Vertebrae" and "The Gall Bladder." He was also the author of many articles in scientific and medical publications.

At the time of his death, Dr. George was radiologist at the Brooks Hospital, Brookline, the Glover Memorial Hospital, Needham, and at the Massachusetts Institute of Technology Infirmary, and also a consultant at the Attleboro, the Cape Cod and the Lynn hospitals. He had formerly served as a consultant radiologist at the Boston Dispensary, the Boston City Hospital, the Children's Hospital, the New England Hospital for Women and Children and the Forsyth Dental School.

Dr. George was a member of the American Roentgen Ray Society, a past chancellor of the American College of Radiology, a member of the Radiological Society of North America, the New England Roentgen Ray Society and the American Medical Association.



Arial Wellington George

24, 1948. Dr. George was born in Yonkers, New York, in 1882. He prepared for Tufts College at Tilton Academy and was graduated from the Tufts Medical School in 1906. Dr. George lived in Wellesley Hills and maintained an office in Boston for thirty-five years and had served in the clinical as well as the research field.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. Barton R. Young, 3401 North Broad St., Philadelphia, Pa. Annual meeting: Jefferson Hotel, St. Louis, Mo., Sept. 26-29, 1950.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Biltmore Hotel, New York, N. Y., May 25-26, 1950.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill. Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY

Secretary, D. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. through April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the University Club.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul E. RePass, 306 Republic Bldg.,

Denver 2, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Lochr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Harvard Club.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. F. H. Ghiselin, 111 East 76th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Boyd Isenhardt, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. G. P. Keefer, 1930 Chestnut St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. K. C. Corley, 1835 Eye St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Benjamin Copleman, 280 Hobart St., Perth Amboy, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO**SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA**

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.

Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:

New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. J. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. R. de G. Burnard, 170 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA**SOCIEDAD ARGENTINA DE RADIOLOGIA**

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGÍA, FILIAL DEL LITORAL

President, Dr. Francisco P. Cifarelli. Meets second

Wednesday each month, at 7:00 P.M., at 663 Italia St. in Rosario.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE**SOCIÉTÉ BELGE DE RADIOLOGIE**

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

ČESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloristr. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

SCIENTIFIC EXHIBIT

The Scientific Exhibit at the Fiftieth Annual Meeting of the American Roentgen Ray Society held in Cincinnati, Ohio, October 4 to 7, 1949, was among the best that the Society has had presented, and the Scientific Exhibit Committee, under the Chairmanship of Dr. C. Allen Good, gathered together a most representative group of exhibits and the Committee had also cooperated thoroughly by furnishing space accommodations very close to the Commercial Exhibit halls. The various exhibitors themselves contributed in no small way to the success of the exhibits by giving generously of their time in explaining the purport and the details of their exhibits; and the attractiveness of the display and the scientific interest of the various subjects chosen was stimulating and undoubtedly accounted for the popularity of the exhibits this year. The Society proposes to change the viewing boxes in such a manner as not only to better display the exhibits but to lessen the work entailed in mounting and placing the viewing boxes. This in itself will add a great deal to the future Scientific Exhibit section.

There follows a brief description of the exhibits shown and the various awards given.

An exhibit entitled "Cerebral Arteriography" was presented by C. R. Hughes, M.D., R. E. Wiese, M.D., and J. R. Hannan, M.D., Cleveland Clinic Foundation, Cleveland, Ohio. This consisted of representative cases from a review of 150 cerebral arteriograms, showing localization of tumors by vascular displacement, tumor stains associated with various neoplasms, arteriovenous anomalies and aneurysms. The exhibit included charts giving the diagnostic criteria in such studies, the indications for the study as well as the contraindications, and a detailed chart giving the technique of the cerebral arteriography. The exhibit was beautifully displayed and the cases shown were of extreme interest, demonstrating the value of such a diagnostic procedure. Two types of cases were shown, those with primary vascular lesions and a second group illustrating space-taking lesions.

"Cerebral Arteriography; Cerebral Vessel

Catheterization" was the title of an exhibit by Karl F. Kesmodal, Jr., M.D., Dan C. Donald, Jr., M.D., and Stacy L. Rollins, Jr., M.D., Jefferson Hospital, Philadelphia, Pennsylvania. The exhibit consisted of (a) roentgenograms showing selective injection of cerebral arteries with barium paste in cadavers; (b) sketches and photographs of dissected gross specimens; (c) description of a method of cerebral arterial catheterization and injection of specific arteries with opaque medium in vivo. There were photographs of the equipment used, and roentgenograms of arteries so injected. In the new technique the common carotid is punctured percutaneously and a small radiopaque catheter is passed under roentgenoscopic control into the internal carotid to the cavernous portion.

An exhibit entitled "Tumors of the Lung; a Pathologic and Roentgenologic Study of Surgical Lesions" was presented by J. R. McDonald, M.D., L. B. Woolner, M.D., C. Allen Good, M.D., and A. H. Bulbulian, D.D.S., Mayo Clinic, Rochester, Minnesota. The exhibit presented the pathologic and roentgenologic manifestations of bronchogenic carcinoma, adenoma of the bronchus, pulmonary hamartoma, alveolar cell tumors, metastatic lesions and a miscellaneous group of rare tumors of the lung. The pathologic histology and gross morphology was demonstrated by means of models and photographs of gross and microscopic specimens. Roentgenograms of each type lesion were included. The exhibit was an extensive and beautifully presented one, and received a Certificate of Merit from the Committee on Awards.

Another exhibit on the lung was "The Captive Lung" by J. E. Lofstrom, M.D., D. A. Koch, M.D., W. M. Tuttle, M.D., and P. V. O'Rourke, M.D., Wayne University College of Medicine, Detroit, Michigan. The exhibit consisted of reproductions of various types of captive lung as a result of organizing hemothorax, empyema, pneumothorax and tuberculous effusion. Serial studies were shown, including the early stage of disease, decortication and results. The exhibit was beautifully arranged and detailed descriptions were given of the cases at the time of admission to the hospital and the subsequent films showing the successive changes following operative interference and re-expansion of the lung.

"Coin-Like Pulmonary Lesions" was the title of an exhibit by C. C. Birkelo, M.D., H. J. Klos, M.D., and W. A. Chickering, M.D.,

Herman Kiefer Hospital, Detroit, Michigan. This consisted of an analysis of 98 consecutive cases discovered to have coin-like lesions in a tuberculosis service. The cases represented those in contact with tuberculosis and those found by chance in survey and pre-employment roentgenograms. A description was given of the criteria for classification. An attempt was made to determine the source and ultimate fate of this type of lesion. Representative types were shown. The display was housed in illuminating shadow boxes specially designed for the exhibit and 14 by 17 inch films were used which added enormously to the value of the exhibit. Summary of the 98 consecutive coin-like lesions: proved tuberculosis, 36 cases; undiagnosed or benign, 60 cases; adenocarcinoma, 2 cases.

"Angiocardiographic Studies of the Pulmonary Artery" was the subject chosen for an exhibit by J. E. Miller, M.D., Parkland Hospital, Dallas, Texas. Much confusion exists concerning the pulmonary conus and the pulmonary artery. Angiocardiographic studies demonstrate clearly that the pulmonary conus or outflow tract of the right ventricle is not seen as a part of the left cardiac border in the posteroanterior view. The bulge along the left cardiac border which may be prominent in at least nine different conditions represents the pulmonary artery. Since it may be either the main pulmonary artery or its left branch, this bulge should be called the pulmonary artery segment. Examples were shown of the various abnormalities of the pulmonary artery.

Benjamin Felson, M.D., and Henry Felson, M.D., University of Cincinnati, College of Medicine, Cincinnati, Ohio, had an exhibit on "Localization of Pulmonary Densities from the Posteroanterior Roentgenograms." In this a method for determining the lobar or segmental location of pulmonary lesions from the frontal view of the chest was described and illustrated. It was shown that when a pulmonary density lies adjacent to the heart, the cardiac border is obliterated; when the pulmonary density lies posterior to the heart, the cardiac border remains visible.

An exhibit entitled "Mediastinal Lesions" was presented by Wm. C. MacCarty, Jr., M.D., M. D. Tyson, M.D., and John E. Withee, Hitchcock Clinic, Hanover, New Hampshire. Included in this were cases histories, roentgenograms and photographs (specimens, or operations, or photomicrographs) of lesions pro-

ducing mediastinal masses. No attempt was made to include all types of lesions occurring in this area. A wide variety of lesions was shown emphasizing the difficulties encountered in making accurate diagnosis of pathological conditions existing in the mediastinum. This exhibit was awarded a Certificate of Merit.

From the New York Hospital, Cornell Medical Center, New York, John A. Evans, M.D., and Ted R. Smalldon, M.D. had prepared an exhibit on "Mediastinal Emphysema." Mediastinal emphysema probably occurs much more frequently than is generally recognized. It is a complication that presents itself in a great variety of diseases and while usually benign, it may occasionally be fatal. The exhibit consisted of charts, diagrams and film transparencies. The mechanisms of production of mediastinal emphysema and the pathways by which air gains access to the mediastinum were illustrated by chart and diagram transparencies. A series of transparencies of roentgen examinations illustrating the roentgen features of typical examples was also presented together with short case histories and suggestions relative to the importance of early roentgen diagnosis. A tabulation was also shown of a large series of cases from the New York Hospital illustrating the great diversity of conditions in which this complication may occur.

An exhibit entitled "The Angiocardiographic Diagnosis of Operability in Lung Cancer" was presented by Charles T. Dotter, M.D., Israel Steinberg, M.D., and Cranston Holman, M.D., The New York Hospital, Cornell Medical Center, New York. The exhibit comprised angiocardiographic studies of the vascular structures in the presence of lung cancer. Certain findings were demonstrated which point strongly to a diagnosis of inoperability. The angiocardiographic signs of inoperability in lung cancer include: (1) partial or complete stenosis of either branch of the pulmonary artery within the pericardium; (2) occlusion of the mediastinal great veins due to tumor; (3) demonstration of mediastinal metastases by the contrast delineation of deformities of adjacent vascular structures; (4) demonstration of pericardial invasion by tumor.

An exhibit entitled "The Roentgenologic Examination of the Colon" was presented by Clyde A. Stevenson, M.D., Robert D. Moreton, M.D., and Everett E. Seedorf, M.D., Scott and White Clinic, Temple, Texas. The exhibit consisted of three parts: (1) equipment and mate-

rials with explanation of exact procedures necessary for complete examination of the colon; (2) nine plastic moulages simulating actual roentgenoscopic examinations and disclosing various pathologic changes which may be encountered; (3) moulages of the pathologic specimens which were demonstrated by roentgen examination, and films illustrating practically all types of neoplastic lesions of the colon. The plastic moulages demonstrated the necessity of oblique projections in order to demonstrate lesions of the colon. This is an excellent teaching exhibit and was beautifully conceived and executed. This exhibit received a Certificate of Merit.

"Diagnosis of Lesions in and about the Fundus of the Stomach" was the title of an exhibit by William H. Smith, M.D., Edsel S. Reed, M.D., and Everett L. Pirkey, M.D., University of Louisville, School of Medicine, Louisville, Kentucky. It consisted of the reproduction of films illustrating the uses of an air-filled balloon as an additional aid in the differential diagnosis of lesions in and about the fundus of the stomach. The following advantages are claimed: (1) definite differentiation between intragastric and extragastric masses under the rib cage; (2) a means of obtaining good double contrast roentgenograms of the stomach; (3) controlled intragastric pressure at any location in the stomach; (4) a means of indirect palpation of the fundus of the stomach is now available. A paper on this subject was published in the July, 1949, issue of the JOURNAL.

An exhibit entitled "Routine Operative Cholangiography" was presented by Maurice D. Sachs, M.D., and P. F. Partington, M.D., Crile Veterans Administration Hospital and Western Reserve University School of Medicine, Cleveland, Ohio. A portion of the exhibit gave the indications for technique and results of operative cholangiography. The remainder of the exhibit consisted of reproductions of representative cases, together with sketches illustrating important points and pertinent operative findings, such as calculi, odditis, pancreatitis, and tumors.

"New Concepts of the Etiology and Surgical Treatment of Hirschsprung's Disease" was the title of an exhibit by Orvar Swenson, M.D., E.B.D. Neuhauser, M.D., and Harold F. Rheinlander, M.D., The Children's Medical Center, Boston, Massachusetts. A series of roentgenograms demonstrated an area of nar-

rowing and dysfunction in the rectosigmoid with dilatation of the colon above this. Recordings of colon peristalsis were demonstrated and drawings of new operative technique and results in the treatment of 30 cases were shown. This exhibit demonstrated in a remarkable manner the new concepts of the etiology and treatment of Hirschsprung's disease. The exhibit was illustrated with roentgenograms of barium enema studies, colored photographs of the specimens and photographs of some of the subjects before and after operation showing the remarkable results obtained from such a surgical procedure. This exhibit was awarded a Certificate of Merit.

An exhibit entitled "Gastrointestinal Roentgenographic Observations in Post Vagotomy" was given by Charles A. Priviteri, M.D., Lawson Veterans Administration Hospital, Chamblee, Georgia. The exhibit was based on work performed on 47 cases of peptic ulcer, 40 being duodenal ulcers and 7 jejunal ulcers. The work was a combined venture between the roentgen-ray and surgical services at the Bronx Veterans Administration Hospital, New York, from July, 1946, to June, 1948. The follow-up and all roentgen examinations on these cases were done by the author. The shortest follow-up was three months and the longest three years, the average of all cases being two years. The studies included preoperative gastrointestinal series on all selected cases and postoperative gastrointestinal series at two weeks, one, three, six, twelve, eighteen, twenty-four and thirty months. Additional roentgenograms were obtained for study of the esophagus, small intestine, colon, gallbladder, and intravenous pyelogram. These examinations were performed at various times after vagotomy in order to obtain a representative response of each organ to vagotomy. One of the important conclusions drawn from their roentgen studies is that vagotomy without gastroenterostomy is no more effective for the treatment of peptic ulcer than any other method.

The exhibit "Alimentary Tract Obstruction in Infancy" by William A. Evans, Jr., M.D., and George A. Miller, M.D., Children's Hospital of Michigan, Detroit, Michigan, was a presentation of roentgenograms showing atresias in the alimentary tract at various levels from the esophagus to the anus, several instances of intrinsic stenosis and obstructions resulting from malrotation and duplications.

Roentgenograms were also shown to illustrate meconium ileus, hypertrophic pyloric stenosis, intussusception, and several types of functional alimentary tract obstruction.

"Cysts of the Kidneys" was the title of an exhibit by Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis, Indiana. There were shown pyelographic findings characteristic of various types of renal cysts found in the patients of a large private general hospital in a five year period.

An exhibit entitled "Porphyria: A Cause of Neuromuscular Small Intestinal Disturbance" was presented by Samuel H. Fisher, M.D., and Robert R. Stanley, M.D., Greenville General Hospital, Greenville, South Carolina. The exhibit consisted of five mounts which discussed the disease and presented a proved case of porphyria. Porphyria is a disease in which an inborn error of pigment metabolism allows the excess production of porphyrins. In porphyria, the porphyrins produce a severe small intestinal disturbance by interfering with the nerve impulses to the small intestine or by irritating the musculature directly. Porphyria as a cause of small intestinal disturbance has apparently not been previously noted in the American roentgenologic literature.

An exhibit entitled "Differential Diagnosis of Abdominal Tumors" was shown by Samuel Brown, N.D., and Archie Fine, M.D., Jewish Hospital, Cincinnati, Ohio. The differential diagnosis of extragastroenteric tumors is based upon certain fundamental anatomical principles, namely: (1) The stomach, intestines and solid organs, within the limits of normal variations, occupy a constant position in the abdominal cavity and maintain an invariable relationship to each other. (2) The stomach and intestines are, relatively speaking, freely movable structures. Their position, shape and the distribution of their contents depend upon the position, shape and size of their neighboring structures and the position of the body as a whole. (3) In the presence of an enlarged organ or an abdominal mass, alterations may take place in the position and shape of the stomach and intestines. These alterations are more or less characteristic, depending upon the organ which is involved. (4) A knowledge of these distinguishing characteristics has enabled the authors to discover the presence of tumors and determine with a high degree of accuracy their exact origin. (5) The roentgen technique which

was applied in this study depends upon the three dimensional method which makes use of the anterior, posterior, left and right lateral horizontal positions. (6) A number of roentgenograms were shown to illustrate various abdominal tumors as revealed by this method.

"Polypoid Lesions of the Colon" was the title of an exhibit by Robert M. Potter, M.D., Northwestern University Medical School, Chicago, Illinois. The exhibit demonstrated (1) certain experimental work using phantoms and experimental lumens, showing desirable barium densities and technical factors to best record on roentgen films small intraluminal masses in the colon; (2) certain clinical cases with history, roentgen studies and pathological specimens of polypoid lesions of the colon. There was included in the exhibit a compression device designed by Dr. Hollis Potter which incorporates within a wire frame a bladder which is filled and controlled by a rubber bulb and valve. This compression device has been found very useful in gastrointestinal examinations, used most often in roentgenographing the patient in the prone position or in oblique angles. Regulated pressure can be used over the distal portion of the stomach and duodenum to study the mucosal pattern. This apparatus has been particularly helpful in separating overlapping groups of redundant sigmoid, colon and in thinning barium by compression over sites of known or suspected bulb lesions and permits better differentiation of the lesion.

An exhibit entitled "Barium Enemas: The Value of Tannic Acid and Post-evacuation Films" was presented by Arthur C. Christie, M.D., Fred O. Coe, M.D., Aubrey O. Hampton M.D., and George M. Wyatt, M.D., The Radiological Clinic of Drs. Groover, Christie and Merritt, Washington, D.C. The authors have used tannic acid in conjunction with post-evacuation films as an integral part of the barium enema examination in over six thousand cases over a period of two years. Comparison of post-evacuation films taken during this period with films taken before institution of the use of tannic acid leaves no doubt that tannic acid produces a more accurate anatomical study of the colon. In substantiation of this finding, the incidence of polyps alone in their clinic has increased over 500 per cent during the two year period. The exhibit consisted of numerous illustrations of the normal and abnormal colon as seen on post-evacuation films

made following the use of tannic acid in the barium mixture. Interpretation of these roentgenograms necessitates a new and different conception of the appearance of the normal and abnormal intestine.

An exhibit entitled "Late Results of Radiation Therapy of Bone Lesions" was shown by T. Leucutia, M.D., Department of Radiology, Harper Hospital, Detroit, Michigan. This exhibit consisted of a series of photographs illustrating the late results obtained by radiation therapy in various types of bone lesions. The material was divided into the following groups: I, sarcomatous tumors including osteogenic sarcoma, chondrosarcoma, Ewing's sarcoma, multiple myeloma and angioendothelioma; II, metastatic tumors from primary malignancies of different locations such as carcinoma of the breast, carcinoma of the prostate, lymphosarcoma and Hodgkin's disease; III, giant cell tumors; IV, bone cysts, including simple cysts, infective dental cysts, silent cysts and fibrous dysplasia; V, benign tumors including ossifying hematoma, osteoid osteoma, recurrent osteochondroma, multiple chondroma, hemangioma, angiochondroma and myxoma; VI, metabolic disturbances, such as Gaucher's disease, and VII, granulomatous histiocytic lesions such as Schüller-Christian disease and eosinophilic granuloma. In the majority of the cases the final result was shown ten to twenty-five years after the treatment. Photographs of the original roentgenograms in each case were contrasted with those of the roentgenograms illustrating the final results so as to bring out the complete degree of bone restoration which had occurred. Photomicrographs of the histopathologic sections were also presented. This exhibit was awarded a Certificate of Merit.

"Diagnostic Tracer Technique: The Application of Radioactive Tracers to Localization and Differential Diagnosis of Various Lesions" was the title of an exhibit by Lawrence Reynolds, M.D., Kenneth E. Corrigan, Ph.D., Henrietta S. Hayden, Ph.D., and J. O. Reed, M.D., Harper Hospital, Detroit, Michigan. The exhibit illustrated the technical application of a radioactive tracer to some specific diagnostic problems, particularly the differentiation of mediastinal masses and the early detection of cancer of the thyroid and its metastases. The major considerations involving the chemistry, the physiology and the technique of utilization of tracers were shown. One side of the exhibit

frame illustrated technical limitations due to the interfering action of medications which include iodine, potassium thiocyanate, sulfa drugs or other chemotherapeutic agents which inhibit the action of the tracer. A second panel illustrated the detection of a malignant lesion and its metastases. The third panel illustrated the differentiation of mediastinal masses by use of the radioisotope. The fourth panel illustrated the problem of the mixed thyroid gland, which includes toxic localizations with non-toxic enlargements, producing a complex diagnostic problem. A model was shown which simulates various types of thyroid lesions and a Geiger counter was available to illustrate the method of detection. The type of probe necessary which was specially developed for diagnostic tracer technique was part of the equipment. Composite charts illustrating typical uptake and excretion in the various types of thyroid disorders were shown. This exhibit was awarded the Bronze Medal.

An exhibit entitled "Scattered Radiation in Fluoroscopic Rooms" was shown by Russell F. Cowing and Charles K. Spalding, New England Deaconess Hospital, Boston, Massachusetts. Measurements have been taken of scattered radiation from the fluoroscope in horizontal and upright positions, using a phantom in place of the patient and with varying size of port. The room size has been varied by use of temporary partitions and the wall material has also been varied. The exhibit was presented by a series of charts and photographs.

An exhibit entitled "Lead Glass Fabric Protective against Roentgen and Beta Rays" was presented by V. W. Archer, M.D., George Cooper, Jr., M.D., H. D. Hebel, M.D., John G. Kroll, M.D., and D. A. Cunningham, M.D., University of Virginia, Charlottesville, Virginia. The high incidence of leukemia among radiologists, and the experimental production of leukemia by irradiation in mice, certainly strongly indicates a connection. Measurements were made on stray radiation received in various parts of the body, and a gown was developed of lead glass fibers to protect the body where not protected by the usual lead rubber apron. The gown covers the arms and drapes down over the legs so that the entire body which by tests receives an appreciable amount of radiation is protected. Protection against beta radiation of atomic fission products was also demonstrated. Two plies of this fabric cuts out 85 per cent of

beta radiation from P^{32} . Each ply weighs 28 ounces per square yard. The Committee on Awards selected this the outstanding exhibit at the meeting and awarded it the Silver Medal.

"Roentgenographic Facsimile" was the title of an exhibit by J. Gershon-Cohen, M.D., and A. G. Cooley, Chester County Hospital, West Chester, Pennsylvania. This included an improved facsimile apparatus for rapid transmission of roentgenographic and cardiographic facsimiles over commercial telephone wires or radio. The exhibit comprised a demonstration of the apparatus in operation.

Cesare Gianturco, M.D., Carle Hospital Clinic, Urbana, Illinois, had an exhibit entitled "Small Cassette Changer". This cassette changer holds six 10 by 12 inch cassettes, measuring $1\frac{3}{4}$ by 24 by 13 inches. A cassette can be exposed every half second or at longer intervals. The position of the patient can be checked roentgenoscopically before exposure.

"The Rapidograph and Its Clinical Applications" was the title of an exhibit by Wendell G. Scott, M.D., Washington University School of Medicine, St. Louis, Missouri. The exhibit consisted of a series of photographs and diagrams illustrating the development and construction of the rapidograph. The techniques that are used with the rapidograph in cardiovascular angiography, aortography, cerebral angiography and in arteriography were described and examples of each were shown together with a beautiful series of films. It has proved of great advantage in preoperative diagnosis both in heart conditions and intracranial conditions because it offers an improvement over previous techniques. The films are made automatically every half second on light, compact, easily handled equipment. Another advantage is the use of a Bucky grid providing greater clarity and definition in the films. The roentgenograms are taken on a roll film which is a recent development, being an adaptation of aerial photographic equipment. This exhibit was awarded a Certificate of Merit.

The Committee on Scientific Exhibits of the American Roentgen Ray Society presented an exhibit entitled "A Comparison of Fluorescent and Incandescent Lighting for Transillumination of Roentgenograms and Colored Transparencies." The Scientific Exhibits Committee had been instructed to investigate the advisability of using fluorescent lighting in standard exhibit frames. Fluorescent lamps, while giving

off light of a slightly different character from that emanating from incandescent types, require less current and generate less heat for the same quantity of light. The exhibit consisted of two parts. Colored and black and white transparencies were duplicated in each part, one illuminated by incandescent and one by fluorescent lamps. Members of the Society were asked to compare the two types of illumination and indicate their preference. Also included in the exhibit was a two-sided illuminator using fluorescent lighting which had been constructed for the Radiological Society of North America. The American Roentgen Ray Society is indebted to the Radiological Society for the opportunity to inspect this new type of illuminator. For his part in the designing of this new type of viewing box, Clarence E. Hufford, M.D., Toledo, Ohio, was awarded a Certificate of Merit.

"Bone Metastases Occurring in 600 Cases of Carcinoma of the Uterine Cervix" was the title of an exhibit by Edwin L. Lame, M.D., and Joseph H. Hanson, M.D., Jeanes Hospital, Philadelphia, Pennsylvania. With additional Cases Loaned by Eugene P. Pendergrass, M.D. The discovery in recent years of an unusual number of bone metastases in uterine cervical cancer prompted a review of the 600 cases given treatment for this disease in a twenty year span of one tumor hospital. Comparable analyses are rare in the literature. A study was made of the symptoms, chronology, roentgen characteristics, radiation treatment and prognosis. Skeletal metastases occurred in 0.8 to 7 per cent in other series; 14 out of 600 cases in their own series. Diagrams were presented showing the probable routes through the vertebral veins in accordance with the work of Batson.

An exhibit entitled "Roentgen Study of Soft Tissue Pathology in and about the Knee Joint" was presented by Raymond W. Lewis, M.D., Hospital for Special Surgery, New York, New York. This consisted of a roentgenographic study of normal and abnormal soft tissues in and about the knee joint, with a discussion of the diagnostic features.

"Uterosalpingography" by Tom M. Fullenlove, M.D., Franklin Hospital, San Francisco, California, consisted of a demonstration of cases of sterility showing minor pathological changes and anomalies. Special emphasis was put on the demonstration of the cervical canal and its relation to sterility. This portion of

uterosalpingography is neglected in the usual studies.

"Vitamin D-Resistant Rickets" was the title of an exhibit by John F. Holt, M.D., and Arthur L. Tuuri, M.D., University of Michigan, Ann Arbor, Michigan. A relatively rare form of rickets occurs usually first recognized in the post-infantile period. Although the roentgenologic findings are essentially those of other types of rickets, certain features suggest the diagnosis if it is kept in mind. Differentiation from renal rickets is extremely important because patients with the refractory variety respond remarkably to large doses of vitamin D. Roentgenograms of eight different patients were included in the exhibit.

An exhibit on "Degenerative Disease in Diabetics" was presented by J. H. Marks, M.D., and M. A. Kellett, M.D., New England Deaconess Hospital, Boston, Massachusetts. The exhibit was concerned with the study of a group of 250 patients whose diabetes began before the age of fifteen and who have now been followed fifteen or more years. Attention was directed particularly to the high incidence of arterial calcification among these patients, and to the calcification of the vas deferens and neuropathic joints. Statistical charts also referred to retinal, cardiac and renal damage among the diabetics. The patients were those of Dr. E. P. Joslin and associates.

"Urethane Therapy in Multiple Myeloma" was the title of an exhibit by Wayne Rundles, M.D., and Robert J. Reeves, M.D., Duke University Medical School, Durham, North Carolina. The exhibit consisted of (1) a chart "Pathogenesis of Multiple Myeloma"; (2) bone marrow photographs before and after therapy; (3) charts of hematologic and protein responses to therapy; (4) roentgenograms of skeletons selected from 20 patients, and (5) roentgenograms showing skeletal recalcification after therapy. Charts were also shown giving blood serum and urinary protein changes following urethane therapy.

An exhibit of "Military Field Roentgen-Ray Equipment" was presented by the United States Army and the National Bureau of Standards, Washington, D. C. This exhibit consisted of illustrations of the new light weight roentgen-ray field table and transportable roentgen-ray equipment for general, station and evacuation hospital units. This equipment has taken into consideration units to be used in any and all climates. The equipment includes trans-

portable temperature control roentgen-ray film processing units, and the equipment is designed in such a manner that the units are collapsible and can be transported in a very small space. The units are also so designed that they may be utilized in hospitals of the smallest number of patients as well as hospitals demanding larger requirements.

COMMERCIAL EXHIBIT

The Commercial Exhibit at the Fiftieth Annual Meeting of the American Roentgen Ray Society held in Cincinnati, Ohio, October 4 to 7, 1949, was in point of size larger than any held at a former meeting of the Society. Thirty-eight manufacturers had reserved a total of seventy-seven booths. The display filled the Hall of Mirrors with a number in the adjoining foyer and also filled the South Hall on the floor above. Much new apparatus which had been devised since the last meeting was on display. A great deal of thought and effort had been put on the exhibit of each manufacturer and the combined effect was a truly pleasing one and combined with the practical side made the exhibit a focal point which drew the attention of the members and guests. The exhibit halls were practically filled to capacity during the periods set aside for viewing the exhibits but even at other hours of the day the booths seemed well filled with interested radiologists.

The Society extends its thanks to the commercial exhibitors for their large part in making the Cincinnati meeting a most successful one.

The following firms were represented in the Commercial Exhibit:

Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; *Ansco*, Binghamton, N. Y.; *Automatic Seriograph Corporation*, College Park, Md.; *George W. Borg Corporation*, Gibbs Division, Delavan, Wis.; *Bracke-Seib X-Ray Company*, New York, N. Y.; *Buck X-Ograph Company*, St. Louis, Mo.; *Coreco Research Corporation*, New York, N. Y.; *E. I. du Pont de Nemours and Company*, Wilmington, Del.; *Eastman Kodak Company*, Rochester, N. Y.; *Eldo-*

rado, Mining and Refining, Ottawa, Ontario; *Eureka X-Ray Tube Corporation*, Chicago, Ill.; *Fairchild Camera and Instrument Corporation*, Jamaica, N. Y.; *H. G. Fischer and Company*, Franklin Park, Ill.; *Franklin X-Ray Corporation*, Philadelphia, Pa.; *General Electric X-Ray Corporation*, Milwaukee, Wis.; *Grune and Stratton*, New York, N. Y.; *Paul B. Hoeber*, New York, N. Y.; *Kelley-Koett Manufacturing Company*, Covington, Ky.; *Lea and Febiger*, Philadelphia, Pa.; *Liberty Dressing Company*, Gloversville, N. Y.; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Conn.; *F. Mattern Manufacturing Company*, Chicago, Ill.; *Micro X-Ray Recorder*, Chicago, Ill.; *C. V. Mosby Company*, St. Louis, Mo.; *Thomas Nelson and Sons*, New York, N. Y.; *North American Philips Company*, Mt. Vernon, N. Y.; *Pako Corporation*, Minneapolis, Minn.; *Picker X-Ray Corporation*, New York, N. Y.; *Professional Equipment Company*, Chicago, Ill.; *Schering Corporation*, Bloomfield, N. J.; *Frank Scholz X-Ray Engineering Service*, Boston, Mass.; *Standard X-Ray Company*, Chicago, Ill.; *Charles C Thomas, Publisher*, Springfield, Ill.; *Victoreen Instrument Company*, Cleveland, Ohio; *Webster Photocraft*, Webster Groves, Mo.; *Westinghouse Electric Corporation*, Pittsburgh, Pa.; *Winthrop-Stearns*, New York, N. Y.

NEW OFFICERS

AMERICAN ROENTGEN RAY SOCIETY

At the Fiftieth Annual Meeting of the American Roentgen Ray Society held at the Netherland-Plaza Hotel, Cincinnati, Ohio, October 4-7, 1949, the following officers were elected for the year 1949-1950: *President-Elect*: B. P. Widmann, Philadelphia, Pennsylvania; *1st Vice-President*: A. E. Childe, Winnipeg, Manitoba; *2nd Vice-President*: Robert C. Pendergrass, Americus, Georgia; *Secretary*: Barton R. Young, Philadelphia, Pennsylvania; *Treasurer*: Wendell G. Scott, St. Louis, Missouri (re-elected); *Member of the Executive Council*: Earl E. Barth, Chicago, Illinois. The

President is U. V. Portmann, Cleveland, Ohio, and the *Chairman of the Executive Council* is Milton J. Geyman, Santa Barbara, California.

COURSES IN THE TECHNIQUE OF USING RADIOISOTOPES AS TRACERS

The Special Training Division of the Oak Ridge Institute of Nuclear Studies announces that three additional basic courses in the techniques of using radioisotopes as tracers will be held during the winter of 1950.

The courses will be a continuation of a series offered at Oak Ridge during the past year and a half. The courses will run from January 2-27, January 30 to February 25, and March 6-31, 1950. Thirty-two participants will be accepted for each course. Application for the January 2 course should be mailed prior to December 1, 1949.

Each session is divided into laboratory work, lectures on laboratory experiments, general background lectures, and special topic seminars. Experiments will be conducted covering the use and calibration of instruments and the purification and separation of radioactive materials from inert materials and from other radioactive materials. Other laboratory work will be devoted to the application of various radioisotope techniques. Ample time is allowed for library work and conferences with the staff on individual problems.

Seminar topics include the use of tracers in animal and human experimentation, design of radiochemical laboratories, dosimetry, instrumentation, the effects of radiation on living cells, and the principles and practices of radiation protection.

A registration fee of \$25.00 is charged for each participant. Hotel or dormitory facilities are available in Oak Ridge at standard rates and food may be obtained in local restaurants and cafeterias.

Application forms and additional information on the courses may be obtained from Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Insti-

tute of Nuclear Studies, P. O. Box 117,
Oak Ridge, Tennessee.

DR. PENDERGRASS AS VISITING
PROFESSOR OF RADIOLOGY

Dr. Eugene P. Pendergrass of the University of Pennsylvania is spending the week of November 14, 1949, in Louisville as the Visiting Professor of Radiology at the University of Louisville School of Medicine under the auspices of the Commonwealth Fund.

EASTERN CONFERENCE OF
RADIOLOGISTS

The next meeting of the Eastern Conference of Radiologists will be held in Boston, Massachusetts, on Friday and Saturday, March 3 and 4, 1950, as voted by the delegates of the participating societies at the Washington meeting. The Local Committee is preparing an excellent program. Complete details will appear at an early date.

GEORGE LEVENE, M.D., *Secretary*
New England Roentgen Ray Society



BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

INTRACRANIAL TUMORS. By Percival Bailey, Professor of Neurology and Neurological Surgery, University of Illinois. Second edition. Cloth. Price, \$10.50. Pp. 478, with 155 text figures and 16 plates. Springfield, Illinois: Charles C Thomas, 1948.

The monograph by Percival Bailey dealing with intracranial tumors is undoubtedly the most satisfactory one written on this subject. The author has stated clearly and adequately the major points which have to do with the classification, pathology, diagnosis and treatment of these disorders. Moreover, the style of the author is engaging and easy to read, which is in contrast to some medical monographs which are otherwise admirable.

The reviewer for many years has been interested in the diagnostic errors which have resulted from failure to recognize some of the cardinal manifestations of brain tumors. As Bailey says, the most important step in the recognition of such a condition is "to have the possibility of its presence occur to the physician." He emphasizes that the greatest difficulty arises in differentiating primary vascular disease and syphilis of the brain. I should like to add, with regret, that too often patients with frontal lobe tumors are regarded as victims of psychoneurosis for a considerable period of time before the true basis for their complaints is recognized. It is emphasized, however, if the disease is kept in mind and the proper importance attached to severe and persistent headache, repeated small cerebral insults, convulsive seizures, recurrent attacks of vomiting, and failure of vision, with due attention to the general physical, neurological and funduscopic examinations, the diagnosis should be made. In Bailey's opinion, ventriculography is of value from a diagnostic standpoint as expanding lesions of the brain will distort the shape of the ventriculum. He warns, however, that not infrequently the patient's symptoms may be exaggerated and sometimes death results from its use. For these reasons, he believes that this procedure should be employed only when necessary.

The author believes that the classification of intracranial tumors is important because different clinical entities must be segregated for study. It is his opinion, however, that our knowledge is too scanty at present to group them from a pathological standpoint, or according to the tissues from which they arise. His classification into five main divisions is based on "certain familial resemblances of structure and behavior". These groups are as follows: Encephalic tumors, tumors of the covering cells, hypophysial tumors, dysembryomas, and vascular tumors. It is of interest to note that almost one-half (42.6 per cent) are included under the gliomas which are placed under the main division of encephalic tumors. When arranged according to site, he found that of 1108 intracranial tumors, 508 were cerebral, 286 pituitary, 178 cerebellar, 114 cerebellopontine, and 12 brain stem.

There is a selected bibliography of 521 titles arranged alphabetically in the back of the book. Such a type of bibliography serves a useful purpose but many prefer in addition, that all references be placed at the bottom of the page on which the reference has been made.

In general it may be stated that the book is an attractively written, authoritative, comprehensive statement of our present-day knowledge of intracranial tumors from the pen of an experienced surgeon in his field. It is to be recommended to students, practitioners, internists, and those who have a special interest in neurological surgery.

CYRUS C. STURGIS, M.D.

THE SKULL, SINUSES AND MASTOIDS: A HANDBOOK OF ROENTGEN DIAGNOSIS. By Barton R. Young, M.D., Professor of Radiology, Temple University Medical School. Cloth. Price, \$6.50. Pp. 328, with 141 illustrations. Chicago: Year Book Publishers, 1948.

This latest volume of the Handbooks of Roentgen Diagnosis is an outstanding member of this popular and growing family. The author has covered the entire field concisely, succinctly, and in a very readable manner. Basic informa-

tion about the various diseases and disorders of the skull, sinuses and mastoids is summarized adequately and without the inclusion of trivial details or lengthy discussion of debatable theories on etiology or development.

The illustrations are superb, with the text on the opposite page so that the student can easily glance at the illustration while reading the text. The small neat markers are effectively placed on the illustrations and contribute to speedy examination without disturbing the eye.

The author is to be congratulated on the preparation of this splendid book, and the publishers on a superior job of illustration. This book can be unqualifiedly recommended to students and radiologists alike.

WENDELL G. SCOTT, M.D.

ACUTE INTESTINAL OBSTRUCTION. By Rodney Smith, M.S., F.R.C.S., Assistant Surgeon, St. George's Hospital, London; Consulting Surgeon, Wimbledon Hospital; Hunterian Professor, Royal College of Surgeons. With a chapter on Radiological Diagnosis, by Eric Samuel, M.D., F.R.C.S., F.F.R., D.M.R.E., Late Radiologist, The Middlesex Hospital, London. Foreword by Rupert Vaughan Hudson, F.R.C.S. Cloth. Price, \$5.00. Pp. 259, with 102 illustrations. Baltimore: The Williams and Wilkins Co., 1948.

Those interested in intestinal obstruction will want this book, for into its 259 pages is crowded a wealth of information, clearly written, adequately indexed and excellently documented.

After a foreword by Rupert Vaughan Hudson, F.R.C.S. and a brief history of the surgery of acute intestinal obstructions, the subject is dealt with in four sections; namely, pathology, diagnosis, treatment, and individual varieties of acute intestinal obstruction.

The first seven chapters are devoted to the pathology of intestinal obstructions. After a consideration of general pathologic principles obtaining to the problem of intestinal obstruction, the author discusses in detail the pathogenesis of simple obstruction, closed loop obstruction, strangulation, functional obstruction, peritonitis, and protein deficiency. Considerable attention is given to the mechanisms in-

involved in the abnormal physiology that attends intestinal obstruction. Their effects upon the various segments of the bowel involved are reviewed with particular attention to high and low small intestinal obstructions and obstructions of the colon.

The second section of the book deals with diagnosis. Of the latter six chapters, the first concerns the clinical characteristics of the condition and the following five its roentgen manifestations. Eric Samuel wrote this portion of the book and it contains an excellent review of the subject. Of particular interest is his attempt to classify small intestinal obstructions into four "grades" depending upon the number of fluid levels seen and the size of the distended loops of intestine. The concept is thought provoking but requires much more work and analysis of large groups of patients. Worth special attention are the comments that concern roentgenography in the obstructions that develop postoperatively.

The third section deals with treatment. It includes six chapters where the problems of chemotherapy, section drainage, protein deficiency, operations and postoperative treatment are discussed.

The final section is approximately one hundred pages long and includes fourteen chapters. In it, one finds brief, yet comprehensive, discussions of the individual varieties of acute intestinal obstruction. Obstructions due to developmental anomalies, strangulated hernia, volvulus, intussusception and various forms of tumors are included. The obstructions of inflammatory origin, mesenteric vascular occlusions, and the postoperative intestinal obstructions are also discussed. Each type of acute intestinal obstruction receives separate treatment and in each instance, the author attempts to review the mechanics of the obstruction, its differential diagnosis and treatment.

Most of the 102 illustrations are good and enhance the value of the text. The bibliography includes 350 references to the literature. The quality of the paper used is quite satisfactory, the printing permits easy reading, and the book is just large enough to fit in an overcoat pocket. We recommend it without reservation.

PHILIP J. HODES, M.D.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

- Head*
WECHSLER, I. S., and GROSS, S. W.: Arteriography in cerebral vascular accidents.... 749
- Neck and Chest*
WARREN, S., and FELDMAN, J. D.: The nature of lateral "aberrant" thyroid tumors.... 749
LESTER, C. W.: Tuberculosis of the cervical lymph nodes..... 749
JACKSON, C. L., *et al.*: Cancer of the larynx.. 750
BLADES, B.: Mediastinal tumors..... 750
EHLER, ADRIANA, and ATWELL, SUSANNA: Gastric cyst of the mediastinum..... 750
GRAHAM, E.: Bronchogenic carcinoma..... 751
EDWARDS, LYDIA B., LEWIS, I., and PALMER C.: Studies of pulmonary findings and antigen sensitivity among student nurses. 751
ADAMS, J. M.: Primary pneumonitis in infancy..... 752
CARSON, M. J., and GOODFRIEND, J.: Constricting vascular rings..... 753
BEADENKOPF, W. G., *et al.*: Tuberculin, coccidioidin and histoplasmin sensitivity in relation to pulmonary calcifications..... 753
WOOLNER, L. B., and McDONALD, J. R.: Diagnosis of carcinoma of the lung..... 753
SACHS, M. E.: Acute coronary thrombosis occurring in a case of perforating lesser curvature ulcer, undergoing malignant changes..... 754
DOTTER, C. T., and STEINBERG, I.: Diagnosis of congenital aneurysm of the pulmonary artery..... 754
NEUHOF, H., and NABATOFF, R. A.: Angiographic study of the form and function of the remaining lung after pneumonectomy. 754
BURFORD, T. H., and CARSON, M. J.: Visualization of the aorta and its branches by retroarterial diodrast injection..... 755
GROSS, R. E.: Surgical treatment for coarctation of the aorta..... 755
ADAMS, H. D., RUTLEDGE, D. I., and SOUDERS, C. R.: Coarctation of the aorta..... 755
- Abdomen*
GRIMSON, K. S., *et al.*: Vagotomy..... 756
PAULSON, M., and GLADSDEN, E. S.: Gastroscopic appearances following vagotomy.. 756
COLP, R.: Surgical treatment of gastric, duodenal and gastrojejunal ulcer, including the present status of vagotomy..... 756
RICKETTS, W. E., *et al.*: Achlorhydria and peptic ulcer..... 757
COVE, A. M., and CURPHEY, W. C.: Prolapse of redundant gastric mucosa..... 757
POLLARD, H. M., *et al.*: Diagnosis of gastric neoplasms..... 758
MCCLENAHAN, J. E., and FISHER, B.: Idiopathic megaduodenum..... 758
FAXON, H. H., and SCHOCH, W. G., JR.: Gastrojejunocolic fistula..... 758
MCCREADY, F. J., *et al.*: Involvement of the ileum in chronic ulcerative colitis..... 759
PORTIS, S. A.: Idiopathic ulcerative colitis... 759
SAPHIR, W.: Abdominal apoplexy..... 760
SMYTH, M. J.: Congenital absence of the gallbladder..... 760
- Gynecology and Obstetrics*
MONTGOMERY, J. B.: Malignant tumors of the ovary..... 760
ASHTON, DOROTHY L.: Carcinoma of the cervix complicating procidentia uteri..... 760
GRAHAM, RUTH M., STURGIS, S. H., and MCGRAW, J.: Comparison of the accuracy in diagnosis of the vaginal smear and the biopsy in carcinoma of the cervix. 761
- Genitourinary System*
SPATT, S. D., and GRAYZEL, D. M.: Pheochromocytoma of the adrenal medulla... 761
GASUL, B. M., GLASSER, J. M., and GROSSMAN, A.: Extreme hypertension in a child cured by nephrectomy..... 761
GIBSON, T. E.: Lymphosarcoma of the kidney. 761
HACKWORTH, L. E.: Urethrography in infants and children..... 762
DIEHL, W. K., and HUNDLEY, J. M.: Urinary tract changes in cervical carcinoma..... 763
ALBERS, D. D. McDONALD, J. R., and THOMPSON, G. J.: Carcinoma cells in prostatic secretions..... 763
- Skeletal System*
LAVALLE, L. L., and HAMM, F. C.: Osteitis pubis..... 763

- SCHACKELFORD, R. T., and BROWN, W. H.: Restricted jaw motion due to osteochondroma of the coronoid process. 764
- THOMPSON, J. E. M., and TANNER, F. H.: Tumoral calcinosis. 764
- WILSON, J. C., and McKEEVER, F. M.: Traumatic posterior (retroglenoid) dislocation of the humerus. 765
- KLEIN, A., *et al.*: Roentgenographic changes in nailed slipped capital femoral epiphysis. 765
- KEY, J. A.: Survival and growth of an epiphysis after removal and replacement. 766
- COMPERE, E. L.: Avascular necrosis of large segmental fracture fragments of the long bones. 766
- MOORE, J. R.: Delayed autogenous bone graft in the treatment of congenital pseudoarthrosis. 767
- PATRICK, J.: Intracapsular fractures of the femur treated with a combined Smith-Petersen nail and fibular graft. 767
- PHEMISTER, D. B.: Treatment of the necrotic head of the femur in adults. 767
- BABB, F. S., GHORMLEY, R. K., and CHATTERTON, C. C.: Congenital coxa vara. 768
- JOHNSON, E. W., and JANES, J. M.: Metastatic adenocarcinoma of the talus from the rectosigmoid region. 768
- SCHLESINGER, P. T., KEATS, S., and RUOFF, A. C.: Fibrous dysplasia. 769
- FALCONER, E. H., and LEONARD, M. E.: Skeletal lesions in Hodgkin's disease. 769
- PIEDMONTE, M., and SIRTORI, C.: Observation on the comparison between the anatomical and roentgenological appearance of giant cell tumors of bone. 770
- Blood and Lymph System*
- FREEMAN, N. E., and MILLER, E. R.: Retrograde arteriography in the diagnosis of cardiovascular lesions. 770
- MEYER, A. H., and OVERMILLER, W. C.: Use of a nitrogen mustard in Hodgkin's disease and lymphosarcoma. 771
- General*
- BASS, H. E., SCHOMER, A., and BERKE, R.: Coccidioidomycosis. 771
- McNALLY, A. K., and DOCKERTY, M. B.: Carcinoma developing in chronic draining cutaneous sinuses and fistulas. 772
- RADIOISOTOPES**
- CRISTOL, D. S., BOTHE, A. E., and GROTZINGER, P. W.: Radioactivity and urinary tract calculi. 772
- BOYD, G. A., *et al.*: Autoradiographs of C^{14} incorporated in individual blood cells. 772
- MISCELLANEOUS**
- MACKAY, M. W. H.: Viscous diodone as a substitute for iodized oil. 773
- HOWES, W. E., and ALICANDRI, B. B.: Method of roentgenologic examination of the shoulder. 773
- DONALDSON, S. W., and CHENEY, W. D.: Prenatal estimation of birth weight by pelvicephalometry. 773
- KENDIG, T. A.: Simple pelvimeter to be used with the triangulation method of pelvimetry. 773
- JONES, G. E., *et al.*: Iodinated organic compounds as contrast media for radiographic diagnoses. 773
- NOLAN, J. F., and STEELE, J. P.: Carcinoma of the endometrium. 773
- SETALA, K.: Preliminary observations on effects of irradiation upon the chylomicrons in human blood. 774
- FINK, K., and FINK, R. M.: Formation of monoiodotyrosine from radioiodine in thyroid of rat and man. 774
- PATT, H. M., *et al.*: X irradiation of hypophysectomized rat. 775
- BRASCH, A., and HUBER, W.: Reduction of undesirable by-effects in products treated by radiation. 775
- TRUMP, J. G.: Physical basis for high skin tolerance of supervoltage roentgen rays. 775
- DRESSER, R.: Further observations on the use of three million-volt roentgen therapy. 775
- LEVIN, M. L.: Some epidemiological features of cancer. 776
- SIMON, S.: Sudden death following intravenous administration of diodrast. 776



ROENTGEN DIAGNOSIS

HEAD

WECHSLER, I. S., and GROSS, S. W. Arteriography in cerebral vascular accidents. *J.A.M.A.*, Feb. 19, 1949, 139, 502-505.

Encouraged by the results from arteriography in cases of subarachnoid hemorrhage due to vascular anomalies, the authors began to use the method in patients with cerebral vascular accidents. The procedure differentiates cerebral thrombosis from hemorrhage so that treatment with anticoagulants or by surgical intervention, respectively, can be instituted with more certain knowledge of the cause of the cerebral apoplexy.

This report is based on 10 cases (6 of inter-cerebral hemorrhage, 3 of cerebral thrombosis, and 1 of thrombosis of the internal carotid artery). Experience has strengthened the authors' conviction that the procedure should be carried out early if the patient's condition at all warrants it. The arteriographic demonstration of vascular occlusion or displacement of vessels has safely indicated the type of treatment. Thus, arteriography is looked upon as a measure which can in a certain number of cases hasten recovery and prevent permanent damage.—*Henry G. Moehring, M.D.*

NECK AND CHEST

WARREN, SHIELDS, and FELDMAN, J. D. The nature of lateral "aberrant" thyroid tumors. *Surg., Gynec. & Obst.*, Jan., 1949, 88, 31-44.

An analysis was made in 57 cases clinically diagnosed lateral "aberrant" thyroid tumors. Six other cases were not included because they proved not to be tumors on histopathologic examination.

In 49 of the 57 cases there was an associated thyroid cancer; 15 per cent of these were not detected clinically. In the remaining 8 cases the thyroid gland was not received in the laboratory, either because it was removed elsewhere or because it was regarded as uninvolved by tumor at operation.

The histopathology of the tumor in the thyroid and in the lateral masses of the neck was identical in all but one instance. It was usually papillary in structure, though the neoplastic growth patterns were markedly pleomorphic.

In 40 of the 57 cases the lateral tumors were found to be metastases to cervical lymph nodes. In the remaining 17 cases there was no

microscopic evidence that the lateral tumors were either metastatic or derived from embryonal rests.

These neoplasms tend to occur in a younger age group than does cancer in general or than does thyroid disease. The presenting finding is usually only a swelling or nodule in the neck, with an average pretreatment interval of almost four years.

The disease often recurs locally unless completely eradicated by surgery. Follow-up observations must be made over decades rather than years.

The data indicate that most if not all lateral thyroid tumors of the neck are metastases from cancers of the thyroid.—*Mary Frances Vastine, M.D.*

LESTER, CHARLES W. Tuberculosis of the cervical lymph nodes. The present surgical status. *Surg., Gynec. & Obst.*, Dec., 1948, 79, 719-724.

Certain significant changes have taken place to alter the incidence of this disease since Dowd compiled his series of 700 personal cases in 1916.

1. Tuberculosis in dairy herds has almost been eliminated thus removing bovine tuberculosis as a factor. (However, it is believed that bovine tuberculosis accounted for only about 30 per cent of Dowd's cases.)

2. The widespread removal of tonsils and the replacement of the old guillotine operation by enucleation of the tonsils removed an important portal of entry not only for tuberculosis but also for pyogenic infections which lessen the resistance of the nodes to lymph-borne or hematogenous infection with tuberculosis.

3. The great decrease in tuberculosis generally has vastly diminished the chances for exposure. In 1915 a positive tuberculin test in a child over two years of age was not considered of great significance but in 1948 a positive tuberculin test at any time in childhood has considerable diagnostic weight.

Tuberculosis of the cervical lymph nodes may occur at any age but is predominantly a disease of childhood. It is not frequently associated with active pulmonary tuberculosis and is present in only about 5 per cent of the patients admitted for tuberculosis to the pediatric tuberculosis division at Bellevue Hospital. Among the adult patients the association is even less. Nevertheless every case of lymph node tuberculosis should be subjected to a thorough search

for tuberculous foci elsewhere. While the nasopharynx may be the portal of entry, it is quite probable that the neck nodes draining this area are infected by way of the blood or lymph streams from an infection originating in the lungs which may be healed, merely deliquescent, or possibly active.

Treatment. Roentgen therapy has a wide vogue. Unfortunately, it is used in a haphazard fashion without due regard to its limitations, but when indicated it is a valuable adjunctive treatment. It cannot destroy the *Mycobacterium tuberculosis* and is in no sense a sterilizing procedure. Nor can it cause the disappearance of a cold abscess or of caseation necrosis. Its chief effect is to produce fibrosis which is the method by which the body combats the infection. It is, therefore, of value early before caseation necrosis has developed, and late, when cold abscesses drain through chronic sinuses. Its use should be reserved to these indications and it will then be of great value. To continue irradiation of caseous nodes or of cold abscesses submits the patient to useless irradiation.

The treatment of choice is still complete removal in properly selected cases. The ideal time for operation is while the nodes are still relatively discrete.

The judicious use of streptomycin is promising.—*Mary Frances Vastine, M.D.*

JACKSON, CHEVALIER L., BLADY, JOHN V., NORRIS, CHARLES M., and MALONEY, WALTER H. Cancer of the larynx. *J.A.M.A.*, Dec. 11, 1948, 138, 1080-1083.

The authors evaluate end results in 612 patients with cancer of the larynx treated at the Temple University Hospital from 1930 to 1947. Statistics for five year survival are based upon 216 determinate patients treated from 1930 to 1942, inclusive. By determinate, the authors imply the patients did not die of other cause within five years of treatment and were traced. Surgically treated determinate patients included 102 patients treated by laryngofissure with 81 per cent, five year survival; 31 treated by laryngectomy with 66 per cent, five year survival and 69 treated by irradiation with 51 per cent, five year survival. The authors state that survival statistics on patients treated by roentgen irradiation included both intrinsic and extrinsic lesions without palpable nodes, and leave the impression that patients submitted to roentgen treatment had a poorer original prognosis than those treated surgically.

They suggest that three year statistics have some value and that five year statistics are by no means final.

Emphasis is placed on the value of laryngofissure and the value of treatment of recurrences and metastasis with further five year salvage.

BLADES, BRIAN. Mediastinal tumors. *Surg., Gynec. & Obst.*, Jan., 1949, 88, 131-133.

The discovery of a mediastinal mass by routine roentgenologic examination with or without associated clinical manifestations demands positive diagnosis. Should no available diagnostic procedure provide an infallible method to determine preoperatively the exact nature of a mediastinal tumor, only two therapeutic methods are available: radiation therapy and surgical extirpation. With few exceptions the only mediastinal tumor which will respond to radiation therapy is one of lymphatic origin (lymphosarcoma, Hodgkin's disease and others).

The chief source of confusion in the diagnosis of anterior mediastinal tumors is the differentiation between lymphatic tumors, teratoid tumors, thymomas and bronchiogenic cysts. Posterior mediastinal tumors are chiefly of one common variety. Neoplasms of neurogenic origin are by far the most common. Often, definite clinical signs of disease indicate the presence of malignant degeneration and inoperability.

Bronchiogenic cysts are now known to be fairly common. Pericardial cysts may occur. Thymomas are relatively rare.

Tumors which respond to roentgen therapy are usually incurable. Others may be amenable to surgical extirpation.

The choice between radiation therapy and surgical intervention will depend first upon the tentative diagnosis and, second, upon the danger of exploratory thoracotomy. If roentgenologic and clinical evidence indicate the presence of a lymphoma a test dose of radiation should be given. If improvement does not follow in due course, thoracic exploration should be carried out unless the general condition of the patient precludes the use of any type of surgical intervention.—*Mary Frances Vastine, M.D.*

EHLER, ADRIANA, and ATWELL, SUSANNA. Gastric cyst of the mediastinum. *J. Thoracic Surg.*, Dec., 1948, 17, 809-820.

Gastric cysts of the mediastinum are rare, only 27 cases having been reported. Only 2 of these cases were found in individuals over

fifteen years of age, while 19 were in infants under one year of age.

Several theories explaining the development of this congenital abnormality are discussed. The cyst usually protrudes into the right hemithorax (in 21 out of 27 cases). All contain some elements of the gastric wall. Roentgenograms are indispensable in diagnosis of this condition. The dense shadow of the gastric cyst is found in the posterior mediastinum and may extend into the right or left hemithorax. The cyst may contain air if there is a communication with the esophagus or trachea. Fluid levels can be demonstrated frequently. Varying degrees of atelectasis and obstructive or compensatory emphysema of the lung are signs auxiliary of the pressure effects of the cysts. Esophagograms are of great value since displacement or distortion of the relatively mobile esophagus can be demonstrated without risk to the patient. Bronchoscopy and esophagoscopy are rarely indicated and only confirm the knowledge gained from the roentgenograms. Aspiration of fluid from the cyst and demonstration of similarity of fluid produced in the stomach make the diagnosis absolute.

The treatment of gastric cysts of the mediastinum is discussed.

One case is presented by the authors.—*Fred-eric M. Reis, M.D.*

GRAHAM, EVARTS. Bronchogenic carcinoma. (Editorial) *Surg., Gynec. & Obst.*, Jan., 1949, 88, 129-131.

Statistical studies at the St. Louis City Hospital and at the Charity Hospital in New Orleans have shown that, actually, primary carcinoma of the lung is more frequent than that of the stomach. This is primarily a disease of males (about 6 males to 1 female) which occurs during or after middle age. Cough and blood streaked sputum are the two most common symptoms. If the disease arises in a small bronchus at some distance from the main stem bronchus the patient may have no warning symptoms until the condition is too far advanced to be curable.

The author performed the first successful one-stage removal of a lung in a patient who had a squamous cell bronchiogenic carcinoma arising in the main bronchus of the left upper lobe. This was done in 1933. That patient is still living and well. Since this first case the author has performed 296 operations of this sort of which 184 have been for malignant tu-

mors. One of the most distressing features of the problem is the relatively small number of patients who present themselves with a cancer early enough to permit the removal of the lung. In the author's cases only about 25 per cent have had a pneumonectomy.

The operative mortality has steadily declined. In the early years it was 53 per cent but last year (1947) of 20 pneumonectomies for cancer the author had only 2 deaths, a hospital mortality of only 5.1 per cent.

Summary

1. Bronchogenic carcinoma is one of the most frequent forms of cancer.

2. The operation of total pneumonectomy offers hope to those victims of this disease who, prior to 1933, had no hope.

3. Nowadays the principal problem in improving the results is to have patients come for help early enough to permit the operation.

4. This means education of the profession to the recognition of the frequency of this condition, the necessity of early examinations of a proper kind, and the fact that the early case is curable.—*Mary Frances Vastine, M.D.*

EDWARDS, LYDIA B., LEWIS, IRA, and PALMER, CARROLL. Studies of pulmonary findings and antigen sensitivity among student nurses. *Pub. Health Rep.*, Dec. 3, 1948, 63, 1569-1600.

This report is concerned with surveys conducted on student nurses in 76 nursing schools in 10 different, widely separated metropolitan areas. At the time of making the report, more than 23,000 nurses were under study; the object of the investigation is to determine the correlation between pulmonary infiltrates and sensitivity to tuberculin and histoplasmin. Of 12,803 nurses included in the study reported, only 224 showed infiltrates and these were investigated as to sensitivity with regard to type of pulmonary lesion.

Of the 224 showing pulmonary infiltrates, 10 per cent failed to show positive reaction to either tuberculin or histoplasmin; 60 per cent reacted positively to histoplasmin, not to tuberculin; 19 per cent reacted positively to tuberculin, not to histoplasmin and 10 per cent reacted positively to both.

Types of infiltrate were arbitrarily designated as (a) "nodular," which were lesions having more or less circular outline and sharply, clear-cut borders; (b) "poorly circumscribed,"

having poorly defined borders, less dense composition and less homogeneous than the nodular lesions, with borders merging gradually into surrounding lung tissue. Some areas may be fibrotic but some are also "soft"; (c) "fibrosis alone," pulmonary "scar," single or multiple strands, sharply outlined, with no "soft" elements; (d) "non-specific"—gross pneumonias, bronchiectasis, etc. In the group of "nodular" infiltrates, they found 42 per cent of the 224 individuals reacted to histoplasmin, not to tuberculin. In the "poorly circumscribed" group, 10.2 per cent reacted to tuberculin, not to histoplasmin and 12.5 per cent in the "fibrosis alone" group reacted to histoplasmin. While there were some reactors to the other antigen in each group, and to both, the proportion was much smaller. The variability was due to the fact that tuberculin reactors were among those whose infiltrates tended to be in the upper part of the chest with infiltration of less clearly defined nature. The histoplasmin reactors were among those whose infiltrates were scattered generally throughout the lung fields. They noted, also, that there was a tendency for infiltrates associated with histoplasmin sensitivity to be smaller than those with tuberculin sensitivity.

There were 38 who showed mediastinal involvement. Of these only 35 showed calcification; 31 of these reacted positively to histoplasmin, 4 to both histoplasmin and tuberculin, none to tuberculin alone. Of these 35, only 20 showed parenchymal infiltration, and this was most frequently of the nodular type. Three individuals with mediastinal involvement reacted to neither histoplasmin nor tuberculin, none had calcification or parenchymal infiltration.

They were able to follow the course during training of a significant number and found that those with fibrotic type of infiltration showed no change during training. Only one of the group with nodular infiltration showed alteration—this was a transitory increase in size which returned spontaneously to former size within a month. A group of 23 in the "poorly circumscribed" classification reacted to tuberculin alone. Of these, 7 showed increase in size of existing lesions or development of new lesions, were hospitalized or had to discontinue training. Twelve, who reacted to histoplasmin only showed either resolution of lesions, development of more sharply defined margins or conversion to nodular type.

It would appear, therefore, that the majority of nodular lesions are due to histoplasmin infection, the majority of poorly defined lesions, in upper lung fields, are due to tuberculous infection; that the poorly defined group, reacting to tuberculin, are likely to break down and show evidence of activity. The majority of mediastinal node involvements are likely to be due to histoplasmosis infection rather than to tuberculosis.—*Angus K. Wilson, M.D.*

ADAMS, JOHN M. Primary pneumonitis in infancy. *J.A.M.A.*, Dec. 18, 1948, 138, 1142-1144.

The epidemic occurrence of primary pneumonitis in infants has already been recognized. The authors wish, however, to emphasize the sporadic occurrence of the disease; further, the severity of the disease appears to be dependent upon the age and maturity of the patient. The morbidity and mortality were extremely high in prematurely born infants as compared with normal full term babies. The same striking difference in morbidity is noted between newborn, full term babies and older children and adults.

The symptom pattern of cough, dyspnea, and cyanosis usually manifests itself in the more acutely ill patients. The onset is usually abrupt with sneezing and coughing. The febrile response is usually slight, but it may eventually rise to 103°F. Physical findings are few in the milder cases, but in the more acutely ill, cyanosis and dyspnea may be quite marked with an abundant whitish, thick exudate in the pharynx. Rales may be heard in both lungs.

The diagnosis is made by the symptom pattern and by the rather characteristic shadows seen in the roentgenograms of the lungs. The roentgenogram reveals diffuse shadows which are bronchial in distribution and usually widespread but may be confined to a single lobe of the lung. Pharyngeal smears made in the acute stage of the disease reveal a great predominance of epithelial cells containing cytoplasmic inclusion bodies. This finding is considered as helpful in the diagnosis. The treatment is largely symptomatic. Continuous oxygen is beneficial where there is involvement of the lower respiratory tract. Sulfonamides and antibiotics are used primarily to combat secondary bacterial complications.

It is suggested that a full term, newborn infant may be more protected from the disease by passive transfer of protective substance from its mother. Clinical experience suggests

that concentrated gamma globulin may contain protective substances against the agent responsible for primary pneumonitis in infants.—*Wallace M. Roy, M.D.*

CARSON, M. J., and GOODFRIEND, J. Constricting vascular rings; report of two cases with recurrent respiratory infections. *J. Pediat.*, Feb., 1949, 34, 155-165.

Double aortic arch in infancy results in respiratory stridor, recurrent respiratory infections, dysphagia and vomiting. The authors report 2 cases in which recurrent respiratory infections were the predominant manifestation. Illustrative roentgenograms are reproduced showing the typical bilateral indentation of the esophagus in the posteroanterior projection and the posterior indentation in the lateral projection.

Tracheograms showed constriction of the trachea above the carina. Operative correction in one case resulted in cessation of the respiratory infections. The parents of the second child refused operation.

The authors postulate that anomalous vascular rings predispose to respiratory infections by narrowing of the trachea and interference with adequate drainage of the tracheobronchial tree. They advise contrast studies of the trachea and esophagus in all patients with recurring pulmonary infections to exclude vascular ring anomalies.—*Rolfe M. Harvey, M.D.*

BEADENKOPF, WILLIAM G., LOOSLI, CLAYTON G., LACK, HERBERT, RICE, FREDERICK A., and SLATTERY, ROBERT V. Tuberculin, coccidioidin and histoplasmin sensitivity in relation to pulmonary calcifications. *Pub. Health Rep.*, Jan. 7, 1949, 64, 17-32.

The authors report on 6,000 University of Chicago students who were tested routinely with tuberculin, histoplasmin and coccidioidin and the findings correlated with pulmonary calcifications as seen in 70 mm. chest survey films. Films were interpreted without knowledge of antigen sensitivity. Of the tuberculin and histoplasmin 1.4 per cent, and 0.6 per cent of the coccidioidin reactions were regarded as doubtful and not considered in final evaluation; 10 per cent of chest calcifications were regarded as doubtful but, in accordance with practice of other authors, were included as positive in final analysis.

Of the students examined, only 800 were found to have pulmonary calcifications. Of

these, 33.6 per cent failed to react to any of the antigens; 25.6 per cent reacted to histoplasmin; 20.3 per cent reacted to tuberculin and 0.9 per cent reacted to coccidioidin. The groups were further studied for combined reactions to the three antigens, and it was found that 11.6 per cent reacted to tuberculin and histoplasmin, 4.8 per cent to histoplasmin and coccidioidin, 2.6 per cent to tuberculin, histoplasmin and coccidioidin and 0.6 per cent to tuberculin and coccidioidin.

In all age groups under fifty years, histoplasmin reactors were found more frequently than tuberculin, in association with pulmonary calcifications. In the group over fifty years of age, there were no purely histoplasmin reactors but those with histoplasmin and tuberculin sensitivity were two and a half times more frequent than those who reacted to tuberculin alone.

From the roentgenological point of view, it would appear that in a given film showing pulmonary calcification, likelihood of etiology would be, in the order named: (a) either tuberculosis, histoplasmosis or coccidiomycotic infection, (b) histoplasmin infection, (c) tuberculous infection, (d) various combinations of those three, (e) coccidiomycosis. Histoplasmosis is a more frequent cause of pulmonary calcification than is tuberculosis.

They noted that, geographically, both histoplasmosis sensitivity and pulmonary calcifications were more prevalent in the lower Mississippi Basin of the United States.—*Angus K. Wilson, M.D.*

WOOLNER, LEWIS B., and McDONALD, JOHN R. Diagnosis of carcinoma of the lung; value of cytologic study of sputum and bronchial secretions. *J.A.M.A.*, Feb. 19, 1949, 139, 497-502.

The sputum or bronchial secretions of 2,188 patients were examined for carcinoma cells. On the basis of the smears, carcinoma was diagnosed in 200 cases. Of these 200 cases: 190 had a final diagnosis of bronchogenic carcinoma or pulmonary metastatic carcinoma; 4 had carcinoma of the esophagus, larynx, or trachea; 4 were false positives; and in 2 the final diagnosis remained uncertain. In 29 of 74 cases of bronchogenic carcinoma surgically explored, the smears supplied the only preoperative microscopic evidence of carcinoma. In 6 cases of Pancoast's tumor, carcinoma cells were found in the sputum.

Of the 4 false positives: 1 had a chronic tuber-

culous process; 1 had pronounced bronchiectasis; 1 chronic pneumonitis; and 1 had extensive infarction plus an organizing pneumonic process.

The accuracy of this technique varies directly with the experience of the cytologist.

Cytologic examination of the sputum is of great diagnostic value in patients suspected of having bronchogenic carcinoma and in whom bronchoscopic examination is contraindicated.—*Henry G. Moehring, M.D.*

SACHS, MILTON E. Acute coronary thrombosis occurring in a case of perforating lesser curvature ulcer, undergoing malignant changes. *Am. J. Digest. Dis.*, Nov., 1948, 15, 375-378.

Acute coronary occlusion has many times been mistaken for an abdominal catastrophe and, conversely, symptoms due to abdominal conditions may simulate those of a cardiac accident. Diagnosis may be even more difficult if in a case of penetrating ulcer with active symptoms, coronary thrombosis supervenes. In such an instance, one might erroneously attribute the entire symptom complex to an acute perforation and overlook the coronary thrombosis. The following points of interest may be repeated in summing up the case presented: A gastric ulcer may persist for some time without demonstrable roentgen evidence. When coronary thrombosis occurs in a case of a chronic penetrating lesser curvature ulcer during the stage of an acute exacerbation, diagnosis may be difficult. Electrocardiographic studies should be included along with gastrointestinal studies. In the presence of an increased size of the niche the diagnosis of malignancy must be considered and surgery instituted. The occurrence of coronary occlusion with myocardial changes appears to be no contraindication to major surgery, in the absence of cardiac failure.—*Franz J. Lust, M.D.*

DOTTER, C. T., AND STEINBERG, I. The diagnosis of congenital aneurysm of the pulmonary artery. *New England J. Med.*, Jan. 13, 1949, 240, 51-54.

A local aneurysm or a diffuse aneurysmal dilatation of the pulmonary artery is presumed by the authors to be of congenital origin if the known causes of acquired pulmonary artery enlargement can be ruled out. Causes of acquired enlargement include infections of the artery, mitral stenosis, cardiac failure, and a

group of chronic pulmonary disorders accompanied by pulmonary hypertension. Pure congenital pulmonary aneurysm is rare, and should be distinguished from pulmonary artery dilatation secondary to intracardiac septal defect or distal to a pulmonic stenosis.

Two adult patients are described, each with an asymptomatic pulsating mass in the left hilum. Angiocardiograms with neo-iopax showed the mass to be an aneurysmal dilatation of the main stem pulmonary artery, and of one or both of its main branches. The dilated vessel is best demonstrated in the left lateral projection, taken three seconds after beginning the opaque injection.—*Henry P. Brean, M.D.*

NEUHOF, HAROLD, and NABATOFF, ROBERT A. An angiographic study of the form and function of the remaining lung after pneumonectomy. *J. Thoracic Surg.*, Dec., 1948, 17, 799-808.

This paper begins with a survey of the experimental and clinical studies on the subject. The authors thought that a study of the topography of the pulmonary vessels would throw additional light on the question of the change in form and perhaps offer indirect evidence as to changes in function of the remaining lung. Twelve patients ranging in age from eighteen to sixty-two years, who had undergone pneumonectomy for malignant tumors were utilized for angiographic studies. The intervals after pneumonectomy varied from six months to ten years.

The vascular pattern presented an essentially normal arrangement. There were some minor abnormalities, as follows: (1) Varying degrees of displacement of the pulmonary artery towards the operated side, accompanying the mediastinum. (2) Some angulation and a turning on itself of the uppermost medial branch of the remaining pulmonary artery. (3) Visibility of the vessels at a lower level than usual in the lower lobe, delineating a downward displacement of the diaphragm. This is often the only direction in which the lung can expand, for the dead space on the operated side may become rapidly reduced by the presence of fluid and the upward shift of the diaphragm.

The remaining lung expands, but this represents nothing more than an unfolding of the areas in the lower lobes which normally function only on violent exertion. The vascular pattern in the expanded lung points to simple expansion of the lung, but emphysema (de-

crease of function) was not found in this series of cases.

No alteration in size or recognizable thrombosis occurred in the stump of the resected pulmonary artery.—*Frederick Reis, M.D.*

BURFORD, T. H., and CARSON, M. J. Visualization of the aorta and its branches by retroarterial diodrast injection. *J. Pediat.*, Dec., 1948, 33, 675-687.

Visualization of the left side of the heart and aorta following intravenous injection of diodrast is usually not so satisfactory as the visualization of the right side of the heart. Various procedures of injecting diodrast directly into the aorta have been devised. The authors experimented with those methods which employ a vessel originating in the aortic arch. The authors consider the left common carotid artery to be the most suitable vessel for the injection in children.

Their technique includes general ether anesthesia for the patient. Under sterile precautions the left common carotid artery is surgically exposed and isolated with three ligatures. The patient is placed on the tautograph in the right posterior oblique position. The upper ligature is tied to prevent cephalad reflux of the dye. The lowermost ligature is tied loosely and an incision made through which a No. 10 cannula is introduced. The middle ligature is tied around the vessel over the cannula to prevent blood leakage. The lowermost tie is loosened and 30-50 cc. of 70 per cent diodrast is injected rapidly.

With this technique the authors have been able to visualize patent ductus arteriosus and coarctation of the aorta. Illustrative films are reproduced.

The authors feel the method is of value in localizing the point of constriction in cases of coarctation and also in demonstrating the feasibility of surgical resection and anastomosis. Congenital anomalies of the arch are easily demonstrable. The method should be useful in the problem of aortic aneurysms.—*Rolfe M. Harvey, M.D.*

GROSS, ROBERT E. Surgical treatment for coarctation of the aorta. *J.A.M.A.*, Jan. 29, 1949, 139, 285-292.

Gross reports the results of the surgical treatment of coarctation of the aorta in 60 cases.

The most characteristic physical signs of this congenital anomaly are observable in the peripheral circulation. Pulsation in the femoral

arteries is greatly diminished or absent. The blood pressure in the lower extremities is less than in the upper. Evidence of collateral circulation is often observed in adults but not in children.

The roentgen signs in infancy and childhood show cardiac enlargement, or other changes which do not indicate the type of cardiovascular abnormality.

Beyond the first decade the roentgen signs are usually pathognomonic. Chiefly the notching or scalloping of the under margins of the posterior and lateral portion of the ribs due to erosion by the pulsating, tortuous intercostal arteries. The upper and lower three ribs are usually not involved.

The aortic knob is small and lacks its usual prominence. Angiocardiography is most useful. The author prefers to introduce the injection of contrast substance directly into the aorta by way of a catheter threaded through the axillary and subclavian arteries.

The surgical techniques are described briefly. Of the cases reported there was complete relief of hypertension in 41. There were 7 deaths from various causes.—*I. Schwartz, M.D.*

ADAMS, HERBERT D., RUTLEDGE, DAVID I., and SOUDERS, CARLTON R. Coarctation of the aorta. *J.A.M.A.*, Feb. 5, 1949, 139, 362-365.

In the past, prognosis for the patients with coarctation of the aorta has been poor because of the propensity for coarctation to result in heart failure, rupture of the aorta, cerebrovascular accident, or subacute bacterial endocarditis. The recent development of a surgical technique for correcting the anomaly must alert physicians to the possibility of coarctation in young persons with hypertension.

Diagnostic points include: (1) absent or diminished pulsations in the abdominal aorta and femoral arteries (collateral circulation may be adequate to produce pulsation in dorsalis pedis and posterior tibial arteries); (2) unusual pulsations of intercostal arteries; (3) when the patient stoops forward with arms hanging by his side, previously invisible collateral arteries may be seen under the skin of the back and sides of the thorax; (4) the arterial pressure in the legs is too low to be measured or, at least, is lower than in the arms, the reverse of normal (hence pediatricians especially are urged to make a comparison of blood pressure in upper and lower extremities during routine general exam-

inations of their patients); (5) a *loud*, rough, systolic murmur may be heard along the left sternal border and, as well, along the left margin of the vertebral column; (6) characteristic notching of lower rib margins on the roentgenogram (in 75 per cent or a series of 43 cases). Angiography, while seldom required for diagnosis, may yield information helpful in planning surgical treatment.

Surgical treatment is safer, and the results are better, when applied during childhood because then the vessels are more elastic and less friable. Gross has placed the age limits from six to twenty-five years for resection of the constricted area and end-to-end anastomosis. In older patients anastomosis of the left subclavian artery to the descending aorta below the coarctation warrants consideration.

The surgical management of 5 cases of coarctation is described.—*Henry G. Moehring, M.D.*

ABDOMEN

GRIMSON, K. S., RUNDLES, R. W., BAYLIN, G. J., TAYLOR, H. M., and LINDBERG, E. J. Vagotomy. *J.A.M.A.*, Feb. 19, 1949, 139, 508-513.

The experiences, analyzed in considerable detail, are derived from 104 patients who had intractable, frequently recurring, or complicated peptic ulcer and were treated by vagotomy. The conclusions drawn are: (1) Vagotomy without gastroenterostomy has not been a satisfactory surgical treatment for duodenal ulcer. (2) Vagotomy with gastroenterostomy has yielded encouraging results as a treatment for duodenal ulcer. (3) Vagotomy has effected healing of stomal ulcer. (4) Vagotomy has aided in the treatment of benign gastric ulcer, but persistence or recurrence has been frequent. (5) In general, side effects of vagotomy seem to diminish with the passage of time.—*Henry G. Moehring, M.D.*

PAULSON, MOSES, and GLADSDEN, EUGENE S. Gastroscopic appearances following vagotomy. *J.A.M.A.*, Jan. 15, 1949, 139, 151-152.

In a group of cases gastroscopic examination was done following (1) simple vagotomy, (2) vagotomy with gastroenterostomy and (3) vagotomy with subtotal gastrectomy. In the first group, simple vagotomy, gastric dilatation and atony were the findings with peristaltic activity decreased and with little mucosal change. The authors were surprised to find the

pylorus was patulous and continually open rather than spastic as had been surmised before. After a period of a year a tendency toward restoration of normal tone and peristalsis was noted. In the second group, namely vagotomy with gastroenterostomy, the same changes were noted including the gaping of the pylorus. In addition the opening of the stoma tended to be more patulous and less active than seen in gastroenterostomy without vagotomy. Mucosa about the stoma appeared to be somewhat erythematous. In the third group, namely vagotomy and subtotal gastric resection, they found considerable mucosal change in the remaining pouch with erythema and thickening and occasional edema. Again the stomal openings were larger than one usually sees in subtotal gastrectomy and the jejunum showed relatively mild mucosal changes on the one occasion in which it was seen. These observations were controlled using patients without vagotomy and with all other factors the same including preparatory sedation and atropine and no such findings were obtained.—*Arthur J. Present, M.D.*

COLP, RALPH. Surgical treatment of gastric, duodenal and gastrojejunal ulcer, including the present status of vagotomy. *Bull. New York Acad. Med.*, Dec., 1948, 24, 755-771.

Vagotomy as a sole procedure has been abandoned in the treatment of unobstructed duodenal ulcer as a result of Colp's experiences in a series of 21 cases, because 7 of them required further surgery, 2 for recurrent duodenal ulcer, and 5 for gastric dilatation and atony. The completeness of the division of the vagi, as evidenced by the insulin test, bears no relationship to the clinical results. The addition of gastroenterostomy to vagotomy seems to have eliminated the undesirable effects of gastric atony in 26 cases of duodenal ulcer in which it was performed. Whether the incidence of gastrojejunal ulceration will be lessened by the combination of vagotomy and gastroenterostomy, as compared to gastroenterostomy alone, only long range follow-up studies will determine. Gastroenterostomy combined with bilateral infradiaphragmatic vagotomy is the preferred procedure in cases of duodenal ulcer unsuitable for subtotal gastrectomy.

For Colp the subtotal gastrectomy still remains the operation of choice in duodenal ulcer. It has been combined with infradiaphragmatic vagotomy in a series of patients whose pre-

operative acidity was high, and who had a tendency to bleed. There has been no increase in the operative mortality and a slight increase in the postoperative morbidity attributable to the added vagotomy. Whether the incidence of recurrent gastrojejunal ulceration will be diminished remains a subject for further study.

The immediate results of vagotomy in the treatment of gastrojejunal ulceration following gastroenterostomy and subtotal gastrectomy have been excellent. Subsequent follow-up has revealed recurrent ulceration in some cases. In patients considered to be good operative risks, a subtotal gastrectomy with infradiaphragmatic vagotomy is preferable to vagotomy alone for gastrojejunal ulceration following gastroenterostomy. In gastrojejunal ulceration following subtotal gastrectomy, wherever possible resection of the ulcer and further gastric resection combined with infradiaphragmatic vagotomy would seem preferable to the severance of the vagus nerves alone.

Vagotomy is not indicated in the treatment of gastric ulcer.—*Franz J. Lust, M.D.*

RICKETTS, WM. E., PALMER, WALTER LINCOLN, KIRSNER, JOS. B., and HAMANN, ANNA. Achlorhydria and peptic ulcer; further study of the role of peptic activity in the pathogenesis and course of peptic ulcer. *Ann. Int. Med.*, Jan., 1949, 30, 24-39.

Previous studies have tended to establish the invariable presence of acid gastric juice in patients with chronic peptic ulcer and the absence of ulcer in patients with persistent achlorhydria as in pernicious anemia. Murphy and Howard noted roentgenologic evidence of duodenal ulcer in 4 of 440 patients with pernicious anemia; apparently the lesion consisted of roentgenologic deformity (scar) rather than an ulcer crater.

In active duodenal ulcer the question of achlorhydria or even of a low secretory rate almost never arises. Thus, in each of 500 consecutive patients with active duodenal ulcer reviewed, the maximum response to histamine stimulation was above 40 clinical units. Very occasional instances of duodenal deformity due to scarring have been noted in patients with pernicious anemia or gastric cancer but an active duodenal ulcer under such circumstances has never been seen.

The incidence of prolonged achlorhydria following roentgen irradiation is quite low, just how low is impossible to state at present be-

cause of the varying techniques used and the incompleteness of the data. However, adequate information on 139 patients in whom achlorhydria developed is available; complete healing of the ulcer occurred in 134 of these. In the 44 patients with achlorhydria lasting longer than ninety days, complete healing occurred in all. Of the 30 patients with gastric ulcer in whom prolonged achlorhydria was produced, complete healing occurred in all but 2; in these 2 the achlorhydria lasted only two months and two and one-half months respectively. In 102 patients with duodenal ulcer, complete healing occurred in all but 3; in these the achlorhydria lasted less than one month. In 2 cases the initial depression of gastric secretion was not as great as that which occurred later—apparently a delayed reaction due to atrophy of the mucosa resulting from radiation injury. Healing of the ulcer in these 2 cases was somewhat slower but it occurred in both when complete achlorhydria developed.

The conclusions of the authors are: that chronic peptic ulcer occurs only in the association with acid gastric secretion; achlorhydria lasting longer than three months produces complete healing of peptic ulcer irrespective of the age of the patient or the duration of the disease; spontaneous or induced achlorhydria, if permanent, produces permanent healing of peptic ulcer.—*Eugene J. McDonald, M.D.*

COVE, ARTHUR M., and CURPHEY, WILFRED C. Prolapse of redundant gastric mucosa. *Surg., Gynec. & Obst.*, Jan., 1949, 88, 108-114.

In the past the presence of hypermobile redundant gastric mucosa has been such a common and incidental finding by surgeons and roentgenologists that little significance was placed upon it as an etiological factor. Consequently, no attempt was made to correct the condition. Since Scott in a recent article gave impetus to the study of this problem, more and more writers are beginning to recognize its significance as a clinical entity and as the cause of any otherwise unexplained gastrointestinal complaints. It is difficult to understand why this condition should have been so universally overlooked in the past in patients with gastrointestinal disease.

Conclusions

1. Prolapse of gastric mucosa is more common than generally suspected.
2. The diagnosis can only be established

roentgenologically since the clinical picture is extremely variable.

3. Mild degrees of prolapse rarely produce symptoms and probably are only an incidental finding.

4. Moderate or marked degrees of prolapse are often associated with complaints of sufficient severity to cause the patient some degree of disability.

5. The most common complication of prolapse is gastrointestinal hemorrhage.

6. The symptoms of prolapse can be controlled medically in the majority of instances.

7. With symptoms of sufficient degree, failure of response to medical treatment is an indication for surgical treatment. Surgery is also indicated in those patients who have had repeated severe gastrointestinal hemorrhage.

8. The surgical procedure of choice is the simplest which will correct the lesion—antrotomy with removal of redundant gastric mucosa combined with some type of pyloroplasty.
—Mary Frances Vastine, M.D.

POLLARD, H. MARVIN, BRYANT HENRY C., BLOCK, MALCOLM, and HALL, WINSTON C. Diagnosis of gastric neoplasms. *J.A.M.A.*, Jan. 8, 1949, 139, 71-74.

The authors report their experiences in the diagnosis of gastric neoplasms by the examination of cells from the gastric juice. The study was made on the gastric content of 278 patients complaining of gastrointestinal distress. As nearly as possible, the staining technique advised by Papanicolaou was used throughout. The pathologist who examined all slides found that while some positive slides can be evaluated quickly, twenty minutes or more are necessary before a negative preparation can be discarded. Often, more specific cellular changes make an absolute diagnosis by this method impossible. It is emphasized that there is no single criteria of malignancy in the individual cell which may not occur in the normal cell.

In this study, the diagnosis as made by microscopic study of the gastric juice is compared with the clinical diagnosis. The series includes only those cases in which it was felt that a final diagnosis had been established. In the first group consisting of 192 aspirations there was no clinical evidence of carcinoma of the stomach. In 86 per cent of the aspirations, no malignant cells could be found. In 10 per cent the results were indefinite, while 4 per cent were falsely reported as positive for carcinoma. The

second group consisted of 43 patients who were subjected to laparotomy and no histopathological evidence of carcinoma could be found. Normal cells were found in the smears in 72 per cent. Nine per cent of the aspirations were indefinite, while in 19 per cent it was felt that malignant cells were present. In group III 20 aspirations were done on patients in which the final clinical diagnosis was carcinoma but laparotomy was not done and histopathological confirmation was therefore unobtainable. No malignant cells, however, could be found in 60 per cent of these cases. While a positive report was made in only 40 per cent. In the final group of 41 patients, who had histopathological evidence of carcinoma, only 35 per cent of the smears were positive, while 60 per cent were indefinite or negative for carcinoma.

The authors believe that as pathologists gain more experience in the study of the gastric smears, the results may be improved. On a number of occasions, however, where roentgenograms of the stomach have been suspicious, but not conclusive of carcinoma, microscopic studies of the gastric smears revealed definite malignant cells. The diagnosis was substantiated by gastroscopy and proved by laparotomy. In the present state of development, the authors indicate that it is no more than an adjunct to the present accepted methods of examination.
—Wallace M. Roy, M.D.

McCLENAHAN, J. E., and FISHER, BERNARD. Idiopathic megaduodenum. *Am. J. Digest. Dis.*, Dec., 1948, 15, 414-416.

A case of idiopathic megaduodenum is described. Of approximately 250,000 admissions and 3,500 autopsies in the last twenty five years at the Mercy Hospital, Pittsburgh, this is the only case of proved megaduodenum where no etiologic factors could be found.—Franz J. Lust, M.D.

FAXON, H. H., and SCHOCH, W. G., JR. Gastrojejunal fistula. *New England J. Med.*, Jan. 20, 1949, 240, 81-87.

Although gastrocolic fistula is sometimes caused by direct extension of carcinoma of the colon or stomach into the adjacent organ, the great majority of gastrojejunal fistulas result from perforation into the colon of a gastrojejunal ulcer in a patient who has had a gastroenterostomy for peptic ulcer. The incidence of gastrojejunal ulcers after gastroenterostomy varies considerably in different series, and per-

haps averages 3 per cent. Between 9 and 24 per cent of all marginal ulcers perforate into the colon with resultant gastrojejunocolic fistula. Since subtotal gastrectomy is generally replacing simple gastroenterostomy as a surgical treatment of peptic ulcer, the incidence of marginal ulcers, and of gastrojejunocolic fistulas, is steadily decreasing.

The fistulas vary in diameter from a few millimeters to several centimeters, and are lined with a well formed mucosa. The colon may be locally constricted and partially obstructed. Unless the fistula is large, the disposition of the jejunal mucosal folds prevents passage of gastric contents into the colon, but permits regurgitation of colonic contents into the stomach. This is probably the explanation for the fact that the fistula is much more readily demonstrated by barium enema than by barium given by mouth.

The authors present 9 patients with gastrojejunocolic fistula, averaging forty-five years of age at onset of fistula symptoms. The average symptom-free period following gastroenterostomy was nine years, although some patients had no symptom-free period. The period between gastroenterostomy and development of fistula symptoms varied from one to thirty years, averaging eleven years.

Clinical features, in order of frequency, were weight loss, diarrhea, weakness, nausea or vomiting, anorexia, hematemesis or melena, foul breath, and abdominal pain. Barium enema demonstrated the fistula in 5 of 6 patients, while gastrointestinal series with barium by mouth showed it in only 3 of 7 patients.

The treatment of gastrojejunocolic fistula consists of surgical excision of the fistula, with restoration of bowel continuity. After such treatment, however, the liability of the patient to develop a recurrent peptic ulcer is high, estimated at 20 to 40 per cent. The patient should therefore be later subjected to a subtotal gastrectomy, or to vagotomy. The authors report the first case in which transthoracic vagotomy was used, successfully, in the treatment of a duodenal ulcer recurrent after excision of a gastrojejunocolic fistula.—*Henry P. Brean, M.D.*

McCREADY, F. J., BARGEN, J. A., DOCKERTY, M. B., and WAUGH, J. M. Involvement of the ileum in chronic ulcerative colitis. *New England J. Med.*, Jan. 27, 1949, 240, 119-127.

In a series of 103 specimens of bowel from patients with chronic ulcerative colitis at the Mayo Clinic during the years 1935 through 1946, 29, or 28 per cent, showed ileal involvement. The incidence of ileal involvement was approximately the same in the 22 surgical specimens as in the 81 autopsy specimens. The process in the ileum is destructive and denuding, but is readily distinguished from regional enteritis since the bowel wall is not thickened and the lumen not stenosed.

In 22 of the 29 cases, the mucosa of the terminal ileum was diffusely denuded in what appeared to be a direct extension of the process in the neighboring colon across the ileocecal valve. The other 7 showed separate ulcers, 2 mm. to 2 cm. in diameter, with the intervening mucosa apparently normal. In all 29, the ileal process was milder than that in the corresponding colon. Five of the 29 showed perforation through the serosa.

Nineteen of the cases were examined by barium enema. In 10, ileal involvement could be recognized. The average length of the segment demonstrated to be abnormal was 30 cm. In all, the process was continuous with involvement in the diseased colon.

The authors believe that ileal involvement has important clinical significance, and that it is not simply a terminal event in intractable colitis. In 9 of the 29 cases, ileal lesions were known to be present months or years before death. Ileal involvement has occurred both in cases of fulminating disease and in long-standing chronic colitis. The authors suggest that the well known high mortality following ileostomy in ulcerative colitis may be, at least in part, the result of pre-existing ulcerative involvement of the ileostomy site.—*Henry P. Brean, M.D.*

PORTIS, SIDNEY A. Idiopathic ulcerative colitis. *J.A.M.A.*, Jan. 22, 1949, 139, 208-214.

Because this disease begins in the rectum and sigmoid and spreads upward involving all areas of the mucous membrane so diffusely, the author became interested in studying the factors which upset the normal protective mechanisms. He describes the innervation of the bowel and outlines the nervous pathways for the transmission of emotional stimuli. In the early stages of the disease the changes are limited to that portion of the colon innervated by the sacropelvic nerves. Lysozyme (a mucolytic enzyme) is partly influenced by nervous con-

trol. It is secreted in increased amounts under stimulation of the sacropelvic nerves and the resultant loss of mucus protection allows increased activity of pancreatic enzymes in the large bowel and bacteria. With this in mind the psychiatric approach to the therapy of ulcerative colitis seems logical. The author outlines medical and psychiatric management to eradicate the mental causes and to protect the mucous membrane from enzyme activity.—*Arthur J. Present, M.D.*

SAPHIR, WILLIAM. Abdominal apoplexy. *Am. J. Digest. Dis.*, Dec., 1948, 15, 408.

A case of abdominal apoplexy is reported and added to the few described in the literature. The underlying pathology was mesenteric arteriosclerosis. During the observation period of twelve years the clinical symptomatology was indistinguishable from that of the "irritable colon" syndrome. Mesenteric arteriosclerosis should seriously be considered in the etiology and the differential diagnosis of the irritable colon syndrome.—*Franz J. Lust, M.D.*

SMYTH, MICHAEL J. Congenital absence of the gallbladder. *Lancet.*, Feb. 19, 1949, 1, 301-303.

This case is thought by the author to be the first in which cholangiography has been used to confirm the operative diagnosis of congenital absence of the gallbladder.

Congenital absence of the gallbladder is not as rare as is commonly believed. At least 79 cases have been reported in the literature.

This is the case of a seventy-seven year old female who had an exploratory laparotomy October 5, 1942, at which time no gallbladder was found but a stone was removed from a greatly dilated common duct. A "T" tube was placed in the common duct and a postoperative cholangiogram clearly reproduced in the article confirmed the diagnosis of congenital absence.—*J. S. Summers, M.D.*

GYNECOLOGY AND OBSTETRICS

MONTGOMERY, JOHN B. Malignant tumors of the ovary. *Am. J. Obst. & Gynec.*, Feb., 1948, 55, 201-217.

Montgomery presents a study of 107 cases of tumors of the ovary. Eighty-four of these were primary ovarian carcinomas, 7 were metastatic from uterine cancer, 2 were adenocarcinomas occurring in teratomas, 10 were granulosa cell

tumors, 1 was a Krukenberg's tumor, 2 were dysgerminomas, and 1 was a Brenner tumor.

The 84 patients with primary adenocarcinoma were critically analyzed. Fifty-seven per cent of these patients were between the ages of forty and sixty years. Their symptoms often occurred late in the course of their disease. The chief symptoms were pain and enlargement of the abdomen. Less common symptoms were nausea, vomiting, loss of weight, backache, and weakness. Only 5 patients had uterine bleeding which was attributed to the ovarian tumor. Operation is recommended in every patient whose physical condition would permit such surgery even though the growth were extensive. In general, it is noted that the tumors of solid consistency are more actively malignant than those which are cystic or papillary.

The entire group of cases is analyzed from, the point of view of (1) the grade of malignancy (2) histopathological type of tumor, (3) extent or operability of the lesion, and (4) the response to radiation therapy.

Operability and the grade of malignancy are the prime factors which govern the percentage of five year survivals. The papillary cysts give the most favorable prognosis while the solid or partly solid type tumors give a very poor prognosis.

Radiation therapy is recommended as an adjunct in those instances where the growth is not completely removed. The radiologist should be acquainted with the location and the gross extent of the involvement. Since radiation therapy is largely palliative, it should not be pushed to the limit of tolerance in those cases where there is extensive disease. The best statistical results from radiation therapy are in the grade 1 tumors.—*George W. Chamberlin, M.D.*

ASHTON, DOROTHY L. Carcinoma of the cervix complicating procidentia uteri. *Am. J. Obst. & Gynec.*, Feb., 1948, 55, 299-302.

This is a case report of a seventy-four year old female with a prolapsed uterus of four years' duration. Physical examination revealed a fungating growth involving the prolapsed cervix. On biopsy this showed squamous carcinoma, grade 3. The patient was given external irradiation for a total tumor dose of 4,000 r. Four weeks later the protruding mass was smaller and could be reduced and held in place by a pessary. Subsequently, however, the patient had a number of severe hemorrhages from a sloughing ulcer of the posterior lip of the cervix

and she died approximately three months from the time of her first admission to the hospital.

Another case of similar nature is reported in a forty-seven year old gravida eight with procidentia of two years' duration. This patient had a biopsy diagnosis of squamous cell carcinoma of the cervix and was given 4,800 mg-hr. of radium. Three months later a vaginal hysterectomy was done. She was then seen seven years later with a small recurrence in the vagina which was subsequently treated by radium.

The author discusses briefly the incidence of carcinoma of the uterus in procidentia and notes that it is a somewhat rare condition. She recommends that the treatment be the same for carcinoma in a prolapsed uterus as it would be for carcinoma with the uterus inside the vagina.—*George W. Chamberlin, M.D.*

GRAHAM, RUTH M., STURGIS, SOMERS H., and MCGRAW, JOHN. A comparison of the accuracy in diagnosis of the vaginal smear and the biopsy in carcinoma of the cervix. *Am. J. Obst. & Gynec.*, Feb., 1948, 55, 303-307.

The avowed intention of this paper is to examine the accuracy of the cytological and histopathological methods of diagnosis in a group of proved cases of cancer of the cervix. Of 181 cases of primary epidermoid carcinoma of the cervix, both the cytological and the biopsy methods of diagnosis were correct in 81.7 per cent and incorrect in only 1.7 per cent. A false negative biopsy was found in 8.8 per cent and a false negative smear in 7.7 per cent of these patients.

The authors conclude that the vaginal smear is more accurate in their experience in the diagnosis of early carcinoma of the cervix. An extremely high percentage of cases can be diagnosed accurately if the two methods are used together.—*George W. Chamberlin, M.D.*

GENITOURINARY SYSTEM

SPATT, S. D., and GRAYZEL, D. M. Pheochromocytoma of the adrenal medulla. *Am. J. M. Sc.*, July, 1948, 216, 39-50.

Five cases of adrenal pheochromocytoma are presented. These include (1) malignant type with metastases, (2) benign tumor with hypertension (one case paroxysmal and one sustained), (3) benign tumor with no signs or symptoms during life, found accidentally at autopsy.

The malignant variety is very rare, the case in this series being the ninth one on record and

the only one with cerebral metastases. The earliest signs of involvement in this group are those of metastatic disease and moreover, since the histopathologic picture of the benign and malignant types is similar, metastatic disease is the only true criterion of malignancy. The absence of hypertension in those patients in the malignant group is unexplained.

The benign group with paroxysmal hypertension is fairly well recognized but, in those cases with sustained hypertension, the diagnosis must be kept in mind and careful study should be undertaken. In the latter regard, the Roth-Kvale histamine test or the benzodioxane test may be important.

The symptomless lesions do not appear to be precursors of those with symptoms (judging from the comparative ages of patients considered) and the presence of symptoms appears to be independent of the size of the lesion.—*Russell R. Fauernig, M.D.*

GASUL, BENJAMIN M., GLASSER, JULIUS M., and GROSSMAN, AARON. Extreme hypertension in a child cured by nephrectomy. *J.A.M.A.*, Jan. 29, 1949, 139, 305-307.

The authors present a case of extreme hypertension in a nine year old girl due to unilateral atrophic pyelonephritis. Nephrectomy was performed and the blood pressure, the urine, and chemical content of the blood returned to normal and had remained such for twenty-four months following the operation. The pronounced hemorrhagic retinitis noted before the operation was no longer present at the time of last examination. The authors then review the experimental work of Goldblatt and co-workers on this subject, and the literature. They find only 22 cases of hypertension in adults in which blood pressure has remained normal one or more years following operation. In children only 9 cases found in which the blood pressure had remained at a normal level for at least one year following the operation.

The authors point out that every case of hypertension in a child should be carefully studied and if a unilateral kidney involvement is found with the other kidney normal or showing compensatory hypertrophy, an immediate nephrectomy should be performed.—*Robert D. Moreton, M.D.*

GIBSON, T. E. Lymphosarcoma of the kidney. *J. Urol.*, Dec., 1948, 60, 838-854.

Lymphosarcoma may simulate primary renal

involvement when affecting the kidney. The author reports 3 cases of lymphosarcoma in which renal symptoms predominated.

The first case was that of a thirty-one year old white male who had had recurrent attacks of sharp pain in the left loin for six months. Retrograde pyelograms showed lateral and forward displacement of the left ureter and bulging of the upper calices of the left kidney. The pain continued and the patient lost 17 pounds. A renal sympathectomy was performed at which time a psoas muscle abscess was found. The pain and weight loss continued and a laparotomy performed one year after onset of symptoms revealed a hard mass in the left mid-abdomen which was adherent to the kidney and histopathologically proved to be lymphosarcoma.

The second case was a sixty-eight year old white male who had a six weeks' history of pains in the left flank and a 16 pound weight loss. Pyelograms showed a markedly enlarged left kidney with caliceal distortion typical of malignancy. A left nephrectomy revealed a retroperitoneal tumor which surrounded and involved the kidney and proved to be a lymphosarcoma.

The third case was a white male sixty-five years old who complained of left loin pain and burning of urination of four weeks' duration. A mass had been present in the left side of the abdomen for several months. Pyelograms were reported as showing bilateral reduplication of the pelvis of a horseshoe kidney with a large calculus. Autopsy revealed a non-fused kidney with an extensive infiltrating mass, which was lymphosarcoma histopathologically.

Clinically cases of malignant lymphomas may be divided into three groups: (1) those with symptoms of renal colic, due to constriction of the ureter by lymphomatous tissue; (2) those with kidney involvement suggesting primary renal malignancy; and (3) those in which primary retroperitoneal sarcoma is suggested with secondary renal involvement.

Fifty-one case reports of lymphoblastoma, occurring in a ten year period at the Massachusetts General Hospital, showed 64.7 per cent with urinary tract involvement. The terminology and classification of malignant lymphomas is discussed by the author.

Involvement of the kidneys by lymphoblastoma is by metastasis and by direct extension. Primary lymphosarcoma of the kidney is practically nonexistent.

The author describes 4 types of renal involvement by lymphosarcoma:

1. Single metastatic nodule.
2. Multiple metastatic nodules.
3. Capsular, in which the kidney is "engulfed as by a flow of lava."
4. Diffuse parenchymal infiltration resulting in enlargement of the kidney without gross distortion of the architecture.

The author includes illustrative drawings to illustrate the above types.

Symptoms include pruritus, intermittent fever of the Pel-Ebstein type, vague abdominal symptoms, back pain, anemia, weight loss, purpuric manifestations, superficial lymphadenopathy, etc.; the blood picture may or may not be leukemic. The onset is insidious. Acute inflammatory lymphadenopathy must be excluded. Most cases must depend on biopsy for diagnosis.

Nephrectomy has been performed in a few cases of malignant lymphoma with renal involvement without benefit or cure. The latter could not be expected in view of the disseminated nature of the disease. A significant number of cases have been reported in the literature where localized lymphosarcoma, confined to a single kidney, has been subjected to surgical removal and irradiation. Hilling, in a series of 130 patients, found 24.5 per cent five year survival, and 10 per cent eight year survival; 17.2 per cent of the series were apparently cured. Malignant lymphoma is very radiosensitive. Irradiation has a valuable palliative effect. More recently nitrogen mustard therapy has been tried with results similar to those of irradiation.—*Rolfe M. Harvey, M.D.*

HACKWORTH, L. E. Urethrography in infants and children. *J. Urol.*, Dec., 1948, 60, 947-951.

The author employs the contrast medium visco-rayopake as a medium of choice in urethrography of infants and children. A modification of the medium, called rayopake, is now available and is less dense, making it possible to visualize small polyps.

Three to 10 cc. of the medium is injected and a film exposed during the injection, which should be slow and steady. The exposure should be for 1/60 sec. at 40 kv. and 400 ma. using a Lysholm grid. Films are exposed in the anteroposterior and right oblique projections.

The author illustrates his article with normal urethrograms of patients from birth to the age

of twelve. A few examples of pathological conditions are also illustrated.—*Rolfe M. Harvey, M.D.*

DIEHL, WILLIAM K., and HUNDLEY, J. MASON. Urinary tract changes in cervical carcinoma. *Surg., Gynec. & Obst.*, Dec., 1948, 87, 705-715.

Thirty-seven patients comprise the series studied. The status of the urinary tract was determined before and after radiation therapy.

Conclusions

1. The more advanced the original cervical carcinoma, the more frequent is the association of urinary tract dilatation before the initiation of radiation therapy.

2. The development of a hydronephrosis and hydroureter during or after treatment has in every case been associated with advancing malignancy and has invariably proved to be a grave prognostic sign.

3. The majority of patients with carcinoma grades 1 and 2 did not show changes in the urinary tract before therapy and none of the patients in these groups developed a dilatation during the period of time between examinations.

4. Urological studies of all patients who have cervical carcinoma are indispensable for purposes of intelligent evaluation and management.

5. Radiation therapy will not cause stricture of the ureter if the dosage is not excessive and provided the source of the ray is displaced from the ureter by accurate maximal vaginal packing.

6. Each patient in this series received a total of 6,000 milligram-hours of radiation (in two doses of 3,000 milligram-hours each with a three week interval). Three weeks later a course of deep roentgen therapy totaling 6,000 to 8,000 roentgens was administered. Twelve weeks later a second cycle of deep roentgen therapy was given.—*Mary Frances Vastine, M.D.*

ALBERS, DONALD D., McDONALD, JOHN R., and THOMPSON, GERSHOM J. Carcinoma cells in prostatic secretions. *J.A.M.A.*, Jan. 29, 1949, 139, 299-303.

This study was undertaken to prove that carcinoma of the prostate can be diagnosed from a microscopic examination of prostatic secretion.

The cases studied were considered in two groups. The first group consisted of 100 cases

in which a preoperative diagnosis of non-malignant hypertrophy of the prostate had been made.

In the prostatic secretions of each of 3 of these cases, cells and clumps of cells were found which showed characteristics of malignant neoplasm. The diagnosis of malignant neoplasm in these 3 cases was confirmed by histopathological examination of tissues removed by transurethral resection.

In a fourth case malignant disease was found in the resected prostate, although no characteristic cells had been discovered in the secretions preoperatively.

The second group consisted of 41 cases in which a preoperative diagnosis of malignant disease of the prostate had been made. In 17 of these, secretions could not be obtained. Of the remainder there were 13 positive and 3 negative cases in which the preoperative examination of the secretion agreed with the postoperative examination of tissues. Six of the cases in this series were not operated upon. In the remaining 2 cases there was disagreement between the results of examination of the secretion and the histopathological tissue studies.—*I. Schwartz, M.D.*

SKELETAL SYSTEM

LAVALLE, L. L., and HAMM, F. C. Osteitis pubis; its diagnosis and treatment. *J. Urol.*, Jan., 1949, 61, 83-95.

Osteitis pubis is an inflammatory disease of the pubic bone following suprapubic incisions for prostatectomy or urinary bladder conditions. Under expectant treatment the disease is self-limited although usually three to twelve months of prolonged pain and disability occurs. The literature is reviewed by the authors who report 7 additional cases and present a new method of therapy which results in rapid amelioration of symptoms.

The onset of the disease follows operation by three to seven weeks. The onset is sudden with excruciating pain over the symphysis extending to involve the rami of the pubic bones. Locomotion is difficult because of pain. Pain is induced by walking, sitting up, passive spreading of the thighs, and stretching of the adductor muscles. A low-grade fever is present without localized pubic swelling or redness. The etiology is obscure. The first pathological change is a periostitis of the pubic bone which is followed by cartilage destruction of the symphysis and resultant separation of the pubic bones.

Roentgenographic corroboration of the osteitis was not obtainable until one to nine weeks following onset of symptoms. A fuzziness of the periosteum was first noticed. Within two weeks the pubic rami became moth-eaten, simulating metastatic malignancy.

The authors found treatment with intramuscular vitamin B complex and diathermy of great value causing rapid regression of symptoms. In one case in which the above therapy was ineffective, roentgen therapy proved effective. The authors suggest trying B complex first and reserving roentgen therapy for refractory cases. They report their 7 cases in detail and include illustrative roentgenograms. Roentgenograms should be made at weekly intervals.—*Rolfe M. Harvey, M.D.*

SCHACKELFORD, RICHARD T., and BROWN, WEBSTER H. Restricted jaw motion due to osteochondroma of the coronoid process. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 107-114.

In 1943, the authors reported 2 cases of osteochondroma of the coronoid process of the mandible. They pointed out that the tumor had been an unrecognized cause of progressive limitation of motion of the jaw, and that its recognition by roentgenograms taken in the usual position employed for studies of the mandible was unlikely. In this paper they report a follow-up of the original 2 cases, and record 2 additional cases and again call attention to the condition and the means of its recognition and correction.

Important points to emphasize in the diagnosis of the condition are a slowly progressive, painless limitation of movement of the jaw; unilateral occlusion of the teeth; a bony-hard swelling in the region of the zygoma on the affected side; and a bony projection visualized by the roentgenograms in a special position. The important point in the roentgenographic technique is to have the central ray directed tangentially to the cheek of the affected side, instead of being centered on the midline symphysis of the chin. The anteroposterior position usually employed for demonstrating the nasal sinuses may also afford a good view of the lesion.

The fourth case reported differed from the others in that the tumor was osseous rather than an osteochondroma. It arose from the zygoma instead of the coronoid and followed a definite history of trauma with roentgenographic evidence of previous fracture of the

zygoma. The authors included it in the report, however, because it caused, due to its impingement on the coronoid process, the same symptoms of progressive limitation of the jaw.

Treatment consisted of surgical excision. The operative technique is described in detail and it has proved to be satisfactory.—*R. S. Bromer, M.D.*

THOMPSON, J. E. M., and TANNER, FRANK H. Tumoral calcinosis. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 132-140.

Three cases of tumoral calcinosis are reported in this paper. The authors describe a third type of calcinosis, the tumoral, which they add to the previously described types, calcinosis circumscripta and calcinosis universalis. Tumoral calcinosis occurs in young individuals of both sexes. There is probably a familial tendency. The tumors are large, rapidly growing to a definite, self-limited size, they usually occur in or near large joints, bursal sites and in connective tissue, immediately overlying bone and muscle attachments. The tumors are hard and lobulated, have fairly well-defined limitations in contour, are attached firmly to the underlying deep structures, and may show some infiltration into the muscles. There is usually no pain, tenderness, or limitation of joint motion. There is a definite multilocular, cystic arrangement of the tumor, which has thick rubbery walls, showing inflammatory foreign body, giant cell reaction. Deep cystic areas are filled with calcareous material and some milky fluid. Surgical removal relieves the condition. Drainage and secondary infection, which occurred in one of their cases, apparently aggravate metastatic calcification and generalized amyloidosis may develop.

The 3 patients who are reported in this paper were brothers. The sites of the tumors, as well as the microscopic appearance and laboratory data in the 3 cases, were similar. The tumors appeared during adolescence and were self-limited in size, after growing for about one year. Most of the tumors arose near joints in the region of gliding surfaces or bursae, but extended into muscles. The tumors were fairly well defined, lobulated, and fluctuating. They were not accompanied by pain, tenderness, or limitation of motion. Complete removal seems to cure the condition locally, but similar tumors may appear elsewhere. The fatal ending in one case was the result of long-standing infection, due to early secondary infection following

drainage, amyloid changes in the viscera, and unfortunate circumstances accompanying his critical condition when final drainage was attempted. Roentgenograms of 2 of the cases are reproduced.—R. S. Bromer, M.D.

WILSON, JOHN C., and MCKEEVER, FRANCIS M. Traumatic posterior (retroglenoid) dislocation of the humerus. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 160-172.

Eleven patients with posterior dislocation of the shoulder were studied by the authors. One of these suffered a bilateral posterior dislocation, making a total of 12 shoulders in which the head of the humerus was displaced to the retroglenoid position. The cause of the dislocation in 7 of the patients was external trauma. In 3 of them the cause was an epileptic convulsion, one having a bilateral dislocation. One patient suffered a luxation as a result of violent muscle contraction initiated by contact with a live electric wire which suggests that this type of dislocation might be an occasional complication of electric-shock therapy. In 8 of the dislocated shoulders there was concomitant fracture.

In roentgenograms of the posterior dislocations of the shoulder, the humerus is in extreme internal rotation. Loss of the sharp outline of the greater tuberosity and the disappearance of the half-moon shadow of the superimposed glenoid and humerus have been described as useful signs. Attention has been called to the fact that, in a posterior dislocation, the lesser tuberosity of the humerus forms the medial border of the roentgenographic shadow of the humeral head, and also that the lower third of the glenoid may be exposed in the anteroposterior roentgenogram of a patient with posterior dislocation. One author has stated that in an anteroposterior roentgenogram of a posterior dislocation, the greater tuberosity lay directly under and behind the coracoid process. These, the authors consider, are useful signs but they may be simulated if an anteroposterior roentgenogram is taken with the humerus in extreme internal rotation, or with the elbow supported in a Velpeau bandage.

The definite and unmistakable diagnosis of posterior dislocation of the shoulder is made by obtaining both anteroposterior and lateral roentgenograms. In the lateral (axillary) roentgenogram of a posterior dislocation, the humeral head is seen to lie posterior to and outside of the glenoid cavity and to be widely separated from the coracoid process.

Prompt recognition and treatment of posterior dislocation of the shoulder by closed manipulation yield excellent results. Even with early prompt reduction, however, the replacement is unstable and there is danger of spontaneous redislocation. This danger, the authors believe, can be avoided by the simple expedient of tranfixing the reduced head of the humerus to the acromion process with cruciate wires. This does not require an open operation. Failure of early recognition necessitates open operative intervention. The results of late treatment are poor.—R. S. Bromer, M.D.

KLEIN, ARMIN, JOPLIN, ROBERT J., REIDY, JOHN A., and HANELIN, JOSEPH. Roentgenographic changes in nailed slipped capital femoral epiphysis. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 1-22.

In this paper, the authors present roentgenograms illustrating, (1) the results of the treatment of slipped capital femoral epiphysis by nailing in situ and by nailing after osteotomy and replacement; (2) the prevention of further slipping, acceleration of fusion of the epiphysis, and preservation of a relatively normal anatomy of the hip, accomplished by this method; (3) the absence of the accelerated fusion in 4 cases, in which growth persisted until the epiphyseal plate had advanced beyond the end of the nail. In the authors' series there were 31 patients, 4 with bilateral involvement, representing a total of 35 hips, nailed in situ because the amount of slipping was less than 1 centimeter. After an average follow-up period of thirty-two months, the average index of motion was 90 per cent of normal, and the average of percentage of normal hip function was 96. Roentgenograms taken at the end of a seven year follow-up period show the results which can be expected from nailing in situ when the minimal amount of slipping is detected early. Sixteen patients were reported with marked slipping, more than 1 centimeter. They were treated with arthrotomy, osteotomy through the epiphyseal plate, replacement of the head to its anatomical position in relation to the neck, and lateral nailing for fixation. Roentgenograms are shown illustrating the results after an average follow-up period of thirty-three and one-quarter months.

The results of their method of treatment suggest that adequate replacement with a minimal amount of circulatory embarrassment to the femoral head and neck, followed by early

immobilization and weight-bearing with the aid of crutches, is of paramount importance. Treatment of the slipping while it is minimal permits a simpler operative procedure with an excellent prognosis, and eliminates the hazards and the inferior results stemming from the difficult procedure which is indicated after the slipping has become marked.—*R. S. Bromer, M.D.*

KEY, J. ALBERT. Survival and growth of an epiphysis after removal and replacement. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 150-152.

In 1946 the author reported the case of a boy eleven years of age, who had suffered a dislocation of the elbow with a fracture through the neck of the radius and displacement of the head of the radius backward into the elbow joint. He was operated upon about forty-eight hours after the injury and the head of the radius, which included the epiphyseal line and a bit of the neck, was found completely free in the posterior portion of the elbow joint. It was lifted out with forceps, placed in a folded towel, and laid upon the instrument table while a bed was prepared for it. It was then replaced on the neck and the elbow was flexed to 90 degrees. The capsule was sutured around the head, the wound was closed, and the extremity was immobilized in a plaster cast. Thirteen months after the operation it was found that the movements of the elbow were almost normal, the roentgenograms showed the head of the radius united and in satisfactory position. It was Key's opinion that the head of the radius and the epiphyseal line were living.

The patient is now fifteen years old and a little over four years has elapsed since the operation. He plays baseball and states that he is able to throw a baseball as well as other boys on his team. Flexion and extension of the elbow and rotation of the forearm are normal. There is no evidence of shortening of the radius or of deformity of the elbow or wrist. The only abnormality noted is slight soft crepitus on palpation over the head of the radius while the arm was being rotated. Roentgenograms show the head of the radius living and united with the neck in slight angulation. The epiphyseal line appears closed. The boy has an approximately normal right upper extremity.

Key believes that this report affords sufficient evidence to warrant reiteration of the statement that, in children, epiphyses should be re-

placed if possible, because they may survive and the bone may grow normally, even though the epiphysis has been completely separated and is without blood supply. With bone banks now existing, this case is of interest, Key states, because it brings up the perennial question of how much of a bone graft lives. It may constitute some evidence on behalf of the autogenous graft.—*R. S. Bromer, M.D.*

COMPERE, EDWARD L. Avascular necrosis of large segmental fracture fragments of the long bones. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 47-54.

The clinical significance of traumatic devitalization of portions of the shafts of long bones has not been recognized by many fracture and orthopedic surgeons. A large fragment in a comminuted fracture of the femur, tibia, humerus, or one of the bones of the forearm, may be so detached from surrounding soft tissue that nutrient, metaphyseal, and periosteal blood vessels supplying the fragments are separated from it. In such cases, the segmental fragment and sometimes the ends of the two major fragments, are so devitalized that they are in the same situation as a full-thickness autogenous bone graft.

Five cases are reported in detail which demonstrate the typical course of a segmental fracture of a major long bone. The bone which is necrotic retains a density greater than that of the living adjacent bone. This is illustrated in the roentgenograms of the cases reported. This relative difference in density is produced by the fact that the living bone atrophies following the fracture, while the bone which is deprived of its vascularity is unable to atrophy, having insufficient blood supply to take away the opaque mineral salts.

Compere believes that with reasonable certainty a marked delay in union of large segmental fractures of the mid-shaft or ends of a major long bone may be predicted. The larger the separate fragment in a segmental fracture of a long bone, the poorer the prognosis from the standpoint of viability of that fragment. In the event that a fragment is partially devitalized and does not retain enough intact blood vessels to maintain a reasonable exchange of arterial and venous blood, some of the bone cells will die. If most of these cells die, the fragment will become necrotic, although massive sequestration does not occur. Union may then be delayed for many months. With good

fixation, however, healing of the fracture will take place before the large fragment has undergone complete replacement by creeping substitution. If a principal nutrient artery remains uninjured and supplies the large segmental fragment, aseptic necrosis may not occur, and the prognosis for undelayed healing of the fracture is good.—*R. S. Bromer, M.D.*

MOORE, JOHN ROYAL. Delayed autogenous bone graft in the treatment of congenital pseudoarthrosis. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 23-29.

The various theories concerning the etiology of congenital pseudoarthrosis are enumerated by Moore. The etiology still remains obscure. He cites previous case reports in the literature and quotes historical data from the study of Camurati who collected 118 cases from the literature. The histopathological characteristics of the lesion have been generally accepted as conforming to those of acquired pseudoarthrosis. Inert, sclerosed, pointed atrophic bone ends (having the appearance of sucked candy), surrounded by a sleeve of dense connective tissue and developing ultimately the characteristics of a nearthrosis including the cartilage and the joint cavity, are the principal findings in the mobile type. Moore classifies congenital pseudoarthrosis into two types:

1. Pre-pseudoarthrosis. In this stage the long bone is bowed or bowing, the apex of the bow is narrow, the medullary canal becomes obliterated, and spontaneous or induced fracture (often surgical) occurs, followed by pseudoarthrosis.

2. Pseudoarthrosis. Various degrees may occur, from simple fibrous to frank nearthrosis, including sclerosis of the bone ends, cartilage, and joint cavity.

He describes the preparation of the delayed autogenous bone graft, the preparation of the pseudoarthrosis site, the implantation of the grafts, and the after-treatment.

Eight cases are reported with clinical and laboratory data in all of which he accomplished successful osteosynthesis. In 6 of them the deformity was in the leg; in 1 in the ulna and 1 in the femur. The delayed autogenous graft is capable of stimulating osteogenesis. Bony union occurred in each instance. He emphasizes the importance of the continuation or primary immobilization until the medullary cavity has been formed. A bimonthly roentgenographic check-up is essential during the

first two years after operation. Moore feels the follow-up period in all of his cases is probably too short to justify final conclusions. The fact that union occurred in every case in which the delayed graft was used, including those cases in which re-operation was done, is regarded as distinctly encouraging and points to the effectiveness of this type of graft. The treatment of congenital pseudoarthrosis will probably never be entirely effective until the etiology has been determined.—*R. S. Bromer, M.D.*

PATRICK, JAMES. Intracapsular fractures of the femur treated with a combined Smith-Petersen nail and fibular graft. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 67-80.

Patrick believes that in the treatment of intracapsular fractures, the use of a fibular graft with a triffin nail does not increase the mortality, and the addition of the graft lengthens the operation time by only a few minutes. In his small series of cases a much higher proportion of bony union occurred and fewer cases of aseptic necrosis appeared as compared with the published results of cases treated with a nail alone.

In one patient, aseptic necrosis developed in spite of non-weight-bearing for a period of seventeen months. He believes it is evident that lack of weight-bearing does not prevent necrosis, although it may minimize collapse of the head and it may be of some value in delaying the onset of osteoarthritis. Early weight-bearing may result in further impaction and shortening of the neck and this may cause the graft to penetrate the joint. For this reason weight-bearing should be avoided for the first three months, and the fibular graft should be inserted a little less than the depth of the triffin nail.—*R. S. Bromer, M.D.*

PHEMISTER, DALLAS B. Treatment of the necrotic head of the femur in adults. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 55-66.

In this paper 2 cases of necrosis of the head of the femur, one associated with an ununited fracture of the neck and the other with an ununited fracture at the junction of the head and neck, are reported. In the second case, the fracture developed after healing of a primary fracture located distally in the neck. They were treated by drilling two holes across the neck and upper portion of the head and by insertion of a rectangular bone graft into each hole. In a third case, also reported, of ununited fracture

with death of the head of two years' duration, the lower bone graft was inserted across the fracture line deep into the head, while the upper graft was inserted only to the margin of the upper portion of the head.

Phemister states the cases present evidence that drilling and bone-pegging of the upper portion of the necrotic head of the femur which has undergone little or no collapse may increase the rate of transformation of the structure into living bone, shorten the non-weight-bearing period, and decrease the incidence of collapse, deformity, degenerative arthritis and poor functional results.—*R. S. Bromer, M.D.*

BABB, FRANK SHALEEN, GHORMLEY, RALPH K., and CHATTERTON, CARL C. Congenital coxa vara. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 115-131.

Congenital coxa vara is an infrequent deformity of the femoral neck in children, recognized since 1896 and characterized by a defect which pathologically and roentgenologically is not unlike that seen in aseptic necrosis. Except for its frequent association with a short femur, congenital coxa vara seems to occur entirely apart from other congenital deformities and to possess sufficiently distinguishing characteristics to warrant recognition of it as a separate entity.

In this paper, the authors summarize the current concepts of the deformity and differentiate it from multiple congenital deformities and they, in addition, report 15 cases. They state that unless one is familiar with the condition, the correct roentgen diagnosis is usually not made. The femoral neck is observed at once in the roentgenogram to be bent, so that the head is depressed and the distal part of the limb is thereby adducted. The epiphyseal line for the head is more vertical than it is normally, and it appears to be branched like an inverted Y. It is not, however, a branching of the epiphyseal line, but a "disorganized segment," sometimes referred to as the vertical fissure, in which an abnormal ossification process has resulted in a defect not unlike that seen in aseptic necrosis or localized osteochondritis. The greater trochanter is elevated and may have a peculiar beaked appearance. The femoral head is comparatively large, somewhat translucent and lies in the bottom of the acetabulum. The acetabulum may be deformed in outline, shallow and defective inferiorly.

There is still no universal agreement as to

the cause of congenital coxa vara. The authors state that the modern tendency to explain it as an aseptic necrosis makes it all the more essential that the condition be separated from other obvious congenital deformities. They attempt to demonstrate pathologically that the coxa vara occurring as one of multiple congenital deformities is not the same as this infantile lesion, the cause of which may be even postnatal.

The lesion is to be suspected in any child who is born with an obviously short leg or who limps when walking is first attempted. The findings on physical examination suggest a congenital dislocation of the hip, with shortening, high position of the trochanter, and a positive Trendelenburg test. However, there is no telescoping and the femoral head is still palpable beneath the femoral vessels at the groin. The roentgenogram will confirm the diagnosis if the lesion is not mistaken for an ununited fracture of the femoral head, a rare condition in children.

The authors regard congenital coxa vara, as they define it, as a not proved congenital deformity. The frequent association of the lesion with a short femur is probably due to a common etiological factor, possibly avascular necrosis. Coxa vara associated with multiple congenital deformities is not the same lesion as the one with which they are concerned in this paper. Subtrochanteric osteotomy at about six to eight years of age, with wide abduction of the distal part of the limb, is the treatment of choice.—*R. S. Bromer, M.D.*

JOHNSON, E. W., and JANES, JOSEPH M. Metastatic adenocarcinoma of the talus from the rectosigmoid region. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 181-184.

Reports of metastases to an extremity in cases of carcinoma of the rectum are exceedingly rare. A case is reported in this paper, a male, aged thirty-seven, who was operated upon for adenocarcinoma of the rectum. Approximately five years later, he developed intermittent pain and swelling of the left leg and ankle. Roentgenograms of the left ankle showed a destructive process of the posterior superior aspect of the talus. A specimen was removed, the histopathological sections showing adenocarcinoma. There was also evidence of metastatic involvement of the lungs in the roentgenograms of the chest.

The anatomical pathways involved in the

spread of rectal carcinoma are the classical ones, namely (1) direct extension, (2) the lymph vessels, (3) the blood stream, (4) transplantation through the peritoneal cavity. In spite of all that has been written on metastatic growth of tumors, not one of the theories explains the scarcity of metastatic involvement below the knees and elbows. It might be conjectured that the more proximal metastatic lesions cause death before evidence of metastasis to an extremity is evident. It has also been postulated that secondary tumor growths below the knees and elbows are rare because of the decreased temperature of the extremities. Whatever the cause, reports of metastases to the extremities from carcinoma of the rectum are very rare. Weston reviewed the literature and found only 6 cases reported.—*R. S. Bromer, M.D.*

SCHLESINGER, PHILIP T., KEATS, SIDNEY, and RUOFF, ANDREW C. Fibrous dysplasia. *J. Bone & Joint Surg.*, Jan., 1949, 31-A, 187-191.

A case of fibrous dysplasia of the tibia is reported which presented the unusual complication of massive hemorrhage with absorption of a large section of the tibia. The patient showed none of the extraskeletal manifestations of Albright's disease. Because of the long duration of the case and the fear that sarcomatous degeneration had occurred, an amputation of the leg, supracondylar of the right thigh, was performed. The microscopic picture revealed not only the characteristic findings of fibrous dysplasia but also evidence of fairly recent massive hemorrhage and degeneration of tissue.

The authors believe on the basis of their case and also on a similar one reported by Jaffe, that the clinical picture of fibrous dysplasia should be broadened to include the complication of massive hemorrhage. This complication may be suspected in a patient with fibrous dysplasia, who presents a rapidly expanding bone tumor.—*R. S. Bromer, M.D.*

FALCONER, ERNEST H., and LEONARD, MAURICE E. Skeletal lesions in Hodgkin's disease. *Ann. Int. Med.*, Dec., 1948, 29, 1115-1131.

It was formerly believed that Hodgkin's lymphogranuloma spread only through lymphatic tissue. At present the conception that the lesions of Hodgkin's disease may also spread through the reticuloendothelial system appears to be quite well established. Some investigators believe this disease should be considered as a

disease of the reticuloendothelial system.

There appears to be quite general agreement among investigators of Hodgkin's disease that skeletal involvement means marrow involvement. The actual mechanism of marrow involvement has not been adequately demonstrated. Three methods are commonly mentioned: direct invasion from adjoining granulomatous lesions, usually lymph nodes, hematogenous invasion through small lymphogranulomatous emboli, or transference of an agent capable of initiating a focus in situ. This latter method could also initiate a lesion primary in the bone marrow, bearing in mind, of course, that the etiology of Hodgkin's disease is at present unknown. Several authors have reported cases where the first clinical evidence of the disease was demonstrated in the skeleton.

Twenty cases of Hodgkin's disease proved by autopsy were investigated for evidence of marrow involvement. The specimens of marrow studied were the usual routine specimens taken at autopsy either from the sternum or from a rib.

Two types of investigation are recorded in the statistics of this table: namely roentgenologic and postmortem. A comparison of these percentages derived from the two types of study indicate that roentgenologic statistics may be misleading unless the limitations of this method of study are kept in mind. Roentgenologic bone surveys must be carried out on all patients studied and roentgenograms carefully searched for skeletal lesions in order to obtain the true statistical incidence. Critical study of postmortem marrow investigations reveals a similar type of statistical error.

Skeletal lesions are practically synonymous with marrow lesions, the focus originating in the bone marrow and enlarging until it erodes the contiguous cortex of the bone. Occasionally instances are encountered where the granuloma appears to invade the bone from without, entering through the periosteum from contiguous lymphogranulomatous tissue. It is the authors' impression that when this occurs the disease is widespread and fairly well advanced.

It seems reasonable to assume that the marrow and the spleen because of their histological structure may be quite as favorable sites for early proliferation of Hodgkin's lymphogranuloma as lymph nodes. Both marrow and splenic tissue have labile growth potentialities in their cellular components, and their filter propensities with stasis of blood in the sinusoids, might

readily harbor the agent responsible for proliferation of lymphogranulomatous lesions.

The authors believe the incidence of skeletal lesions shown by roentgenologic examination is necessarily incomplete and too low, as marrows with Hodgkin's lymphogranuloma may contain lesions too small to involve the adjacent cortical portion of the bone.—*Eugene J. McDonald, M.D.*

PIEDMONTE, M., and SIRTORI, C. Osservazioni sul confronto fra il quadro anatomico e il quadro radiologico dei tumori giganto-cellulari delle ossa. (Observation on the comparison between the anatomical and roentgenological appearance of giant cell tumors of bone.) *Radiol. med.*, Dec., 1948, 34, 809-822.

The authors are of the opinion that benign giant cell tumors never become malignant nor give rise to distant metastases. In support of this view they state that in those cases reported of malignant giant cell tumors with pulmonary metastases, the histopathological structure has always been that of a sarcoma rather than of giant cell tumor.

They review some of their cases, of their total collection of 18, to demonstrate that benign giant cell tumors may invade locally surrounding tissues and break through the bone cortex. The roentgen findings in these cases may be interpreted as those of a malignant bone tumor. The cellular structure, however, retains all the characteristics of a benign giant cell tumor. These tumors, they believe, remain and behave as benign growths.

In another case they report in detail, they attempt to demonstrate that an osteogenic sarcoma may be mistaken for a benign giant cell tumor histopathologically because the sarcomatous element may be so scanty in certain parts of the tumor that it may be overlooked. The roentgen findings in their case suggested a primary malignant bone tumor. From the tissue examined after extensive curettage of the tumor located in the proximal end of the tibia, a microscopic diagnosis of benign giant cell tumor was made. The area was treated by irradiation, giving a tumor dose of 3,600 r, delivered through four portals. Two months later, amputation of the extremity became necessary and re-examination of tissue removed from the same lesion again resembled a giant cell tumor, except in scattered areas where sarcomatous element could be detected.

Within a year the patient developed distant metastases and died.

Thus the authors show that there may be discrepancy between the roentgenological appearance and the histopathological structure of benign giant cell tumors and that in each case all factors should be evaluated after microscopic examination of the tumor tissue.—*Peter E. Russo, M.D.*

BLOOD AND LYMPH SYSTEM

FREEMAN, NORMAN E., and MILLER, EARL R. Retrograde arteriography in the diagnosis of cardiovascular lesions. I. Visualization of aneurysms and peripheral arteries. *Ann. Int. Med.*, Feb., 1949, 30, 330-342.

Recent advances in vascular surgery have created a demand for more accurate methods of diagnosis. Just as developments in surgery of the abdomen, urinary tract, head, and thorax have been aided by improvements in roentgenographic technique, so advances in vascular surgery may be expected to develop with visualization of the heart and blood vessels after the injection of contrast media.

Visualization of aneurysms of the thoracic aorta and innominate artery was attempted on three occasions but the results were not entirely satisfactory, presumably because of the difficulty of introducing a sufficient quantity of radiopaque material rapidly.

The authors have not been successful in attempts at visualization of the abdominal aorta except in the patient in whom the catheter was introduced through a cannula inserted into the femoral artery. In animal experiments Fariñas showed fluoroscopically that to be successful the injection must first overcome the inertia of the blood flow and, second, must overcome the blood pressure. It may be that injection of a larger quantity of solution under higher pressure would have yielded more satisfactory results. The danger of thrombosis at the site of injection, especially where a large needle is inserted into a small artery, is very real. With the use of 70 per cent diodrast, the possibility of serious systemic reaction should be considered, especially when there is any opportunity for the contrast medium to enter the cerebral circulation. Attention is called to the complications which may result from the use of this method.—*Eugene J. McDonald, M.D.*

MEYER, ANDREW H., and OVERMILLER, W. C.
The use of a nitrogen mustard in Hodgkin's disease and lymphosarcoma. *Ann. Int. Med.*, Feb., 1949, 30, 381-386.

Investigation into the mode of action of mustard gas revealed a type of action of sulfur and nitrogen mustards which is unlike that of any other chemical agent and resembles in many ways that of roentgen rays. The effects of the mustards on lymphoid tissue, coupled with the finding that actively proliferating cells are selectively vulnerable to the cytotoxic action of the mustards, led to its use in the treatment of neoplasms of lymphoid tissue. The amount recommended as a single course is 0.1 mg. per kilogram intravenously on four successive days (a total of 0.4 mg. per kilogram). Subsequent therapy varies with each patient. Nitrogen mustard must be administered only by the intravenous route, taking great care to prevent extravasation of the solution.

Two cases of Hodgkin's disease, treated with nitrogen mustard, methylbis (b-chloroethyl) amine hydrochloride, responded favorably at a period when further roentgen therapy was not considered advisable. Of the 3 cases of lymphosarcoma, treated after further roentgen therapy was not deemed advisable, 1 is leading a useful home life eight months after initial therapy; 1 received marked subjective and objective relief but died in her sleep one month after the last course of therapy, and the third experienced considerable relief from pain, disappearance of peripheral lymphadenopathy, but no relief from dysphagia or vomiting. Autopsy revealed metastatic tumor nodules in the liver and kidneys.—*Eugene J. McDonald, M.D.*

GENERAL

BASS, H. E., SCHOMER, A., and BERKE, R.
Coccidioidomycosis. *Arch. Int. Med.*, Dec., 1948, 82, 519-528.

It is known that about 80 per cent of the long time residents of the endemic area in the southwestern desert area of this country are infected and that about 25 per cent of the military personnel with several months' residence in the endemic area became infected. From 20 to 25 per cent of infections are clinically recognizable.

The primary purpose is to present data on a series of patients residing in New York City with protracted residual pulmonary lesions of

coccidioidomycosis and to discuss the pitfalls in diagnosis.

The residual lesions were of all types, i.e., nodular densities, cavities, mottled infiltrations, fibrosis, pleural effusion and calcification. These residual pulmonary lesions characteristically showed little or no change over a period of observation of from two to five years. All patients gave a history of residence in the endemic area, varying from three months to two years. Skin sensitivity to coccidioidin was observed to diminish with the lapse of time. However, Smith and associates asserted that sensitivity to coccidioidin is durable and that, although it may wane, its loss is usually slow. Thus, while a dilution of 1:1,000 commonly yields strong reactions in early cases, it was found preferable to employ 1:100 and 1:10 dilutions in residual cases. All the patients in this series reacted to coccidioidin in 1:100 dilution. The reactions were usually of a mild type (1 or 2 plus).

A negative reaction to the coccidioidin skin test was misleading in the presence of a disseminating lesion. In such an instance the failure to react to coccidioidin was presumed to be related to energy. However, serologic examination is usually diagnostic and can often be confirmed by recovery of the spherules in a tissue biopsy, from sputum or from draining sinuses. In cases of cavity formation, no evidence of bronchogenic spread or of seeding to other parts of the lung fields, such as occurs commonly in tuberculosis, was observed.

The resemblance of the residual pulmonary lesions to those in tuberculosis was striking. In several of the cases, a diagnosis of tuberculosis had been made after the patient's return to civilian life, usually after a routine chest survey or pre-employment roentgenoscopic examination. In a number of cases, a positive reaction to both the tuberculin and the coccidioidin skin test made diagnosis difficult. In such cases a presumptive diagnosis of coccidioidomycosis was made on the basis of the following evidence: (a) history of exposure in an endemic area; (b) roentgenographic evidence of a pulmonary lesion, usually a solitary cavity or nodular density, which showed no change after months of observation; (c) indication of an identical lesion in the roentgenogram of the chest taken on separation from military service; (d) a positive reaction to the coccidioidin skin test, and (e) absence of tubercle bacilli. Almost

all the patients observed were asymptomatic.—
Eugene J. McDonald, M. D.

McANALLY, ALBERT K., and DOCKERTY, MALCOLM B. Carcinoma developing in chronic draining cutaneous sinuses and fistulas. *Surg., Gynec. & Obst.*, Jan., 1949, 88, 87-96.

The authors wish to emphasize the occurrence of carcinoma in chronic inflammatory sinuses for the following reasons: (1) The development of malignancy on this basis is not particularly rare. (2) The diagnosis can be made clinically at a relatively early stage. (3) The neoplasms are, in general, slow-growing and can be treated successfully if diagnosed during the long latent period which usually precedes the stage of metastasis.

Conclusions

1. Malignant changes in a chronic osteomyelitic sinus should be suspected when a growth appears in the sinus, the discharge becomes more foul-smelling or hemorrhagic, a painful swelling appears and when the roentgenogram reveals a pathologic fracture or areas of rarefaction surrounding the osteomyelitic cavity. There were 9 such cases in the author's series.

2. In this series there were 2 cases in which metastasis occurred from a malignant lesion in a chronic osteomyelitic sinus; these added to the 9 cases reported in the literature make 11 cases in which distant spread occurred.

3. It is proposed that the regional lymph nodes be treated with roentgen rays and that even a prophylactic dissection of these nodes be considered.

4. The transitional epithelium from the erratic glands of the anal crypts probably invades the fistula in ano tracts and this may account for the fact that acini are located in some of the fistulous tracts which have shown malignant change. Three such cases are presented in this series.

5. Malignant disease occurring in a chronic empyemic sinus is a surgical rarity. There was one in this series.

6. When the biopsy reveals epithelial hyperplasia, the sinus or fistula should be excised and blocks studied for evidence of malignant changes. If neoplastic tissue is found, amputation should be done in cases of osteomyelitis and rather radical excision should be done for fistula in ano and empyemic sinuses.—*Mary Frances Fustine, M.D.*

RADIOISOTOPES

CRISTOL, D. S., BOTHE, A. E., and GROTZINGER, P. W. Radioactivity and urinary tract calculi. *New England J. Med.*, Sept. 16, 1948, 239, 427-429.

A patient with a vesical calculus, prostatic calculi, and polycythemia vera was given an oral dose of 6 millicuries of radioactive phosphorus, and five months later a second dose of 10 millicuries, with reduction of hematocrit to normal levels. During the period of observation, the vesical calculus grew larger as observed roentgenographically and through the cystoscope. Two months after the second oral dose of radiophosphorus, the vesical calculus and some of the prostatic calculi were surgically removed. After washing for two days to remove surface urine radioactivity, the stones were placed before a Geiger counter. The vesical calculus was markedly radioactive. Autoradiographs of the bisected stone showed the radioactivity to be localized in a peripheral lamina, presumably that part of the enlarging stone which had been laid down while the patient's urine contained radiophosphorus. The prostatic calculi, which were not in contact with the urine, and which presumably were not growing during the period of radiophosphorus therapy, were not radioactive.—*Henry P. Brean, M.D.*

BOYD, GEORGE A., CASARETT, GEORGE W., ALTMAN, KURT I., NOONAN, THOMAS R., and SALOMON, KURT. Autoradiographs of C^{14} incorporated in individual blood cells. *Science*, Nov. 12, 1948, 108, 529-531.

The individual cells of a rat's blood taken twenty-five hours after the intraperitoneal injection of glycine containing C^{14} in the alpha-carbon atom were smeared directly on a special emulsion, and after a sixty-seven day exposure were developed, stained and photomicrographed.

The identifiable cells were the lymphocytes, polymorphonuclear leukocytes and the erythrocytes. The autoradiographed cells showed varying concentration focally about them of a non-uniformly distributed silver grain. (The number of silver grains per unit area in the autoradiographs is a measure of the relative units of C^{14} incorporated in the cells.)

Most of the lymphocytes autoradiographed, the polymorphonuclear leukocytes occasionally and the erythrocytes rarely. This phenomenon probably lies in the rate of formation and the

relative amounts of nuclear proteins in the three types of cells.

The erythrocytes which autoradiographed apparently were newly formed indicating utilization of C^{14} in the bone marrow and not in the peripheral blood.—*William H. Pfisterer, M.D.*

MISCELLANEOUS

MACKAY, MAURICE W. H. A viscous diodone as a substitute for iodized oil. *Brit. J. Radiol.*, April, 1948, 21, 204-205.

A water soluble solution consisting of 35 per cent of diodone with a varying percentage of polyvinyl alcohol as a thickening agent has been used as a contrast medium. Both substances are non-toxic in the amounts used and, in fact, the author, with others, submitted himself to intravenous injections of this material for proof. The sterilized solution is used primarily for uterosalpingography to replace iodized oil, obviating the danger of inadvertent introduction of the oil into a venous channel, and circumventing the slow absorption from the peritoneal cavity.

It has also been found excellent for injection of fistulous tracts, cystography, and even as a medium for examination of the mucosa of the pharynx and esophagus.

The material has been used for twelve months in amounts up to 60 cc. for one patient, and no untoward symptoms or signs have been noted.—*E. F. Lang, M.D.*

HOWES, WILLIAM E., and ALICANDRI, B. BRUCE. A method of roentgenologic examination of the shoulder. *Radiology*, May, 1948, 50, 569-580.

The authors present a study of the roentgen anatomy of the shoulder locating the sites of the facets of the short rotator muscle tendon insertions with lead foil. From the study, five views are suggested and illustrated with the purpose of (1) locating more accurately the sites of calcification within the tendon sheaths and in the bursa (2) clarifying the exact location of fractures of the tuberosities, and (3) identifying periosteal and subcortical zones of reaction secondary to tendon injury.

The article contains several good illustrations. The study of the roentgen anatomy in the five positions is worth referring to the original article itself.—*Frank J. Riggs, M.D.*

DONALDSON, S. W., and CHENEY, WILLIAM D. Prenatal estimation of birth weight by pelvicephalometry. *Radiology*, May, 1948, 50, 666-673.

The Ball technique was used in determining the size of the pelvis and the circumference and volume of the baby's head. It is concluded that the size of the fetal head is the best known index at the present time for estimating birth weight. Such factors as muscular development, skeletal size and fatty tissue may discredit the method to some extent, yet the error is not more than 10 per cent.—*C. H. Warfield, M.D.*

KENDIG, TOM A. A simple pelvimeter to be used with the triangulation method of pelvimetry. *Radiology*, March, 1948, 50, 395-399.

By means of an easily constructed plastic device, pelvic and fetal head measurements can be made directly from a lateral and an antero-posterior roentgenogram and corrected for distortion with the aid of an incorporated chart, thus increasing accuracy, saving time, and simplifying wet film readings.—*William N. Thomas, M.D.*

JONES, GLENN E., GROHOWSKI, ALPHONSUS L., ROBERTSON, HAROLD D., RAMSEY, GEORGE H., SCHILLING, JOHN A., and STRAIN, WILLIAM H. Iodinated organic compounds as contrast media for radiographic diagnoses. *Radiology*, August, 1948, 51, 225-236.

A comparison was made of four different iodine-organic compounds in regard to their visualization in biliary radicles and common duct in the dog. It was found that both standard gallbladder dye (priodax, for instance) and newer compounds of benzoic acid, delineated liver ducts when injected intravenously. The benzoic acid derivative appeared in the biliary system in ten minutes. When the various compounds were given by mouth, only the benzoic acid outlined the liver radicles.

The possible use of this compound in the study of post-cholecystectomy patients is suggested.—*Robert P. Barden, M.D.*

NOLAN, JAMES F., and STEELE, JAMES P. Carcinoma of the endometrium. *Radiology*, August, 1948, 51, 166-176.

Report of experimental measurement by photographic method of radiation in gamma roentgens delivered to various shaped excised uteri. Under conditions of the experiment radi-

ation from multiple capsule implantations of radium are superior to the usual tandem method for the treatment of endometrial carcinoma. Details should be studied in the original paper.—*E. C. Baker, M.D.*

SETALA, KAI. Preliminary observations on the effects of irradiation upon the chylomicrons in human blood. *Radiology*, June, 1948, 50, 803-810.

In order to further study radiation sickness chylomicron curves of 32 individuals were made. The chylomicron first used by Gage and Fish in 1924 is a method of studying the tiny droplets of fat visible in the blood plasma, after a fatty meal, in light reflected from their surface under the dark field microscope. By counting the number of chylomicrons at stated intervals following a certain method, after a fatty meal a so-called "chylomicron curve" can be constructed.

Since chronic administration of histamine is said to produce the same histopathologic picture as irradiation, including extensive accumulation of sudanophil fat around the central vessels of the liver lobules, histamine studies also were made. In order to eliminate possible errors the persons studied were kept under the same conditions during the whole observation period; the investigations were begun after a rest period of twelve hours; and the examination of the blood was always performed by the same person with the same instruments. It was found that the metabolic rhythm of the mobile visible blood lipids (chylomicron curve) was characteristic for each individual and its form for the same individual in same external conditions remained comparatively constant. The curve usually reached its maximum three hours after the fatty meal and fell to the 0-plane on an average of eight hours after the meal, practically irrespective of whether one or two fatty meals were taken provided the total amount taken was the same.

Irradiation given to persons considered healthy had a definite reducing effect on the mobile blood lipids, especially when given comparatively soon after a fatty meal, and to certain regions of the body. Irradiation of cancer-bearing patients produced similar changes in the amount and metabolic rhythm of blood lipids. In conformity with the clinical observations that the site of the irradiation has a bearing on the irradiation reaction, it was found that treatment over the pelvis, lower abdomen,

liver, and the area of the bifurcation of the common carotid artery, caused distinctly greater changes both in the amount and in the absorption rhythm of the blood lipids. It was also demonstrated that the shorter the interval between the taking of fatty food and subsequent irradiation, the greater the effect of irradiation seemed to be.

The histamine studies showed that histamine also had a strong reducing effect on the amount of blood lipid. The effect was usually the greater, the sooner after the fatty meal the drug was administered. In some cases when given before the meal, it prevented the appearance of chylomicrons in the blood.

The author believes that irradiation causes definite changes in the metabolism of mobile visible lipids in human blood and also that changes of an exactly similar nature may be brought about by histamine acid phosphate administration. When the present observations are considered with work of other investigators it seems likely that irradiation and histamine administration lead to hemoconcentration when the permeability of the capillaries increases and the alterations in the amount of mobile visible blood lipids, especially their decrease, may be considered as partly attributable to the same cause. In other words, the mobile visible blood lipids escape more easily from the blood stream because of the increased permeability of the capillaries.—*Robert K. Arbuckle, M.D.*

FINK, KAY, and FINK, R. M. The formation of monoiodotyrosine from radioiodine in the thyroid of rat and man. *Science*, Oct. 1, 1948, 108, 358-359.

The authors prepared two dimensional filter paper chromatograms and radioautographs of rat thyroid hydrolysates, following intravenous or intraperitoneal administration of 0.05 to 1 mc. of carrier-free I^{131} . Total dosage to the rat thyroids varied from 0.5 to 40,000 rep (roentgen equivalents, physical) of beta radiation, delivered at varying rates.

The chromatograms and radioautographs showed exactly corresponding radioactive spots with R_F values between tyrosine and diiodotyrosine, thought to be monoiodotyrosine, but not conclusively identified as such by crystal analysis.

A chromatogram of the hydrolysate from a biopsy specimen of a patient with thyroid adenoma, taken eight days after ingestion of

12 mc. of I^{131} , showed a radioactive spot corresponding to moniodotyrosine.

Normal rat thyroids were similarly hydrolyzed in the presence of carrier-free I^{131} and only trifling amounts of moniodotyrosine were identified, seeming to indicate that moniodotyrosine is present in the irradiated thyroid before processing. The possibility is noted that iodine containing amino acids may be more easily broken down than are free amino acids.

Continuation of these studies should contribute materially to our increased knowledge of thyroid physiology.—*William S. Wallace, M.D.*

PATT, H. M., SWIFT, M. N., TYREE, E. B., and STRAUBE, R. L. X irradiation of the hypophysectomized rat. *Science*, Oct. 29, 1948, 108, 475-476.

Following lethal doses of roentgen radiation in the rat, there is an initial reduction in adrenal cholesterol, a secondary normal or increased value due to adrenal hypertrophy, followed by a marked terminal fall. The initial reduction can be prevented by administration of adrenal cortex, but the secondary rise and terminal fall are not affected. There is a similar fall in adrenal ascorbic acid following exposure to cold.

It is agreed that these adrenal changes are controlled by the adrenotropic hormone of the pituitary.

Sixty rats received total body irradiation with 750 r, generated at 200 kv.; half of these had been hypophysectomized seven days previously. The characteristic adrenal response to lethal irradiation was not seen in hypophysectomized animals, but the characteristic changes in spleen and thymus were not altered by pituitary extirpation.

Hypophysectomy seemed to enhance toxicity of the radiation, with almost half of the hypophysectomized rats dying within four days of irradiation. No rats with intact pituitary died in the first six days after irradiation and this group showed only 30 per cent mortality in sixteen days.

Hypophysectomy alone is known to produce adrenal atrophy and a drop in adrenal ascorbic acid.

Further studies are planned to determine whether the adrenal cortex is less sensitive to irradiation after hypophysectomy, due to removal of pituitary influence, or whether the adrenal stimulation after irradiation is entirely

dependent on the adrenotropic hormone.—*William S. Wallace, M.D.*

BRASCH, ARNO, and HUBER, WOLFGANG. Reduction of undesirable by-effects in products treated by radiation. *Science*, Nov. 12, 1948, 108, 536-537.

Using the capacitron, food products could be sterilized by inactivation of microorganisms and inhibiting enzymatic action.

Irradiated material often had undesirable chemical changes affecting taste, odor, and appearance.

By-effects were minimized with cooling, pre-cooking, and/or partial air evacuation before irradiation.

The authors' inactivation doses for bacteriophages, viruses, and spores were 5 to 80 times less than previously reported results obtained with beta, gamma, or roentgen radiation.

These discrepancies contradict the "target theory" of inactivation of microorganisms by irradiation.

The high intensity radiation of the capacitron with ultrashort application may be more efficient than that produced at lower intensities with extended exposure time.

Modification of the "target theory" may be necessary.—*William H. Pfisterer, M.D.*

TRUMP, JOHN G. Physical basis for the high skin tolerance of supervoltage roentgen rays. *Radiology*, May, 1948, 50, 649-656.

This article states the physical reasons why the skin tolerance is higher with supervoltages. The ionization produced in the surface region is both less than that available some distance below and composed of electrons of relatively higher average energy and therefore lower biological effectiveness. The increased skin tolerance must disappear almost completely when the radiation beam has traversed a distance below the surface equal to the range of the highest energy electrons which the beam can produce. The biological effect on the skin should be less the higher the voltage.—*C. H. Warfield, N. D.*

DRESSER, RICHARD. Further observations on the use of three million-volt roentgen therapy. *Radiology*, May 1948, 50, 645-648.

The author reports the technique of 3 million volt roentgen therapy using a single port of entry 100 to 150 sq. cm. with a skin target distance of 100 cm., filtration equivalent to 2

mm. lead, 300 to 400 roentgens daily with the total dose up to 5,000 r.

The 10 cm. depth dose is 60 per cent, the skin erythema, both entrance and exit, is not visible and the systemic reaction on the part of the patient is less. This procedure is used in deep-seated lesions, cervical and buccal lesions, but not breast lesions.—*C. H. Warfield, M.D.*

LEVIN, MORTON L. Some epidemiological features of cancer. *Cancer*, Sept., 1948, 1, 489-497.

The increase in cancer mortality has been attributed to improved diagnosis and "aging" of the population. The author shows that the increase has stopped since 1920 in England and Wales and since 1935 in Massachusetts where the data are standardized for age. He also points out that the major increase in mortality took place between 1850 and 1895 prior to the discovery of roentgen rays.

There has been a marked sex difference, with females showing the greatest cancer mortality, until 1920 in England and Wales and 1935 in Massachusetts at which time the rates in males exceeded those in females. This difference, the author believes, is due to improved diagnosis in both males and females which has been counterbalanced in females by improved cure rates.

The author lists forty-five statistically sig-

nificant precancerous lesions and briefly discusses such epidemiological factors as age, socio-economic position, carcinogenic chemicals, radiation, and hereditary factors.—*W. E. Childs, M.D.*

SIMON, SAMUEL. Sudden death following intravenous administration of diodrast. *J.A.M.A.*, Sept. 11, 1948, 138, 127-128.

The basis for this report is a fatality subsequent to the intravenous administration of iodopyracet injection ("diodrast"). The author reviews some of the literature; he states that the incidence figured 1 fatality to 25,000 injections. Two types of death were reported: (1) immediate, due to allergy to the drug, (2) delayed due to pre-existing major renal damage.

He reports a case and states that the clinical impression was that death was of allergic type. On the basis of the postmortem observation, the following precautions were listed and discussed: (1) question patient carefully as to allergy; (2) cutaneous tests performed; (3) oral test performed; (4) drug administered slowly; (5) emergency tray kept available; (6) non-protein nitrogen or urea nitrogen on patient prior to pyelogram; (7) increased danger of jaundiced patients; (8) danger of repeated urographic examinations. A review of the literature showing advantages of these precautions is given.—*Robert D. Moreton, M.D.*



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Vol. 62

DECEMBER, 1949

No. 6

THE RELATIONSHIP OF THE ROENTGENOGRAPHIC APPEARANCE OF THE PULMONARY ARTERY TO PULMONARY HEMODYNAMICS*†

By R. F. HEALEY, J. W. DOW,** M. C. SOSMAN, and L. DEXTER

BOSTON, MASSACHUSETTS

INTRODUCTION

ALTERATIONS in the dynamics of pulmonary arterial blood flow occur in a wide variety of disorders of the heart, the lungs, and the great vessels. The pulmonary artery itself, however, is simply a channel for conducting blood from the right heart to the lungs. Thus, despite the complexities of the underlying disorders, alterations in this simple system are limited to abnormalities of pressure and flow, and intrinsic diseases of the artery. It is the purpose of this paper to determine the changes which are present in the pulmonary artery, as seen on routine roentgenographic and roentgenoscopic examinations, in known conditions of intrinsic disease and altered pressures and flows.

METHODS

Diagnoses of the cases used in this study were based on venous catheterization of the heart and the pulmonary artery.^{1,2,3} Pressures in the pulmonary artery were recorded through the catheter by the method of Hamilton.⁴ Pulmonary artery blood

flows were determined by application of the Fick principle. Oxygen consumptions initially were calculated from regular hospital metabolic rates done just before catheterization. More recently, the consumption of oxygen has been derived from expired air collected in Douglas bags simultaneously with blood sampling, measured in a Tissot spirometer and analyzed for oxygen and carbon dioxide by the Haldane method. Blood samples collected under oil through the catheter from the pulmonary artery and from a systemic artery through an inlying needle were analyzed for oxygen by the method of Van Slyke and Neill.⁵ The oxygen content of pulmonary venous blood was considered equivalent to that of systemic arterial blood provided there was no veno-arterial shunt. When such shunting did occur, the oxygen content of pulmonary venous blood was assumed to equal 98 per cent of the oxygen capacity.

In order to analyze the roentgenographic changes recognizable by routine methods, changes in size and activity of the main pulmonary artery were recorded. The term

* From the Department of Radiology and the Medical Clinic, Peter Bent Brigham Hospital, and the Departments of Radiology and Medicine, Harvard Medical School, Boston.

† This work was supported in part by a grant from the Life Insurance Medical Research Fund.

** This work was done during the tenure of a Post-Doctorate Research Fellowship from the United States Public Health Service.

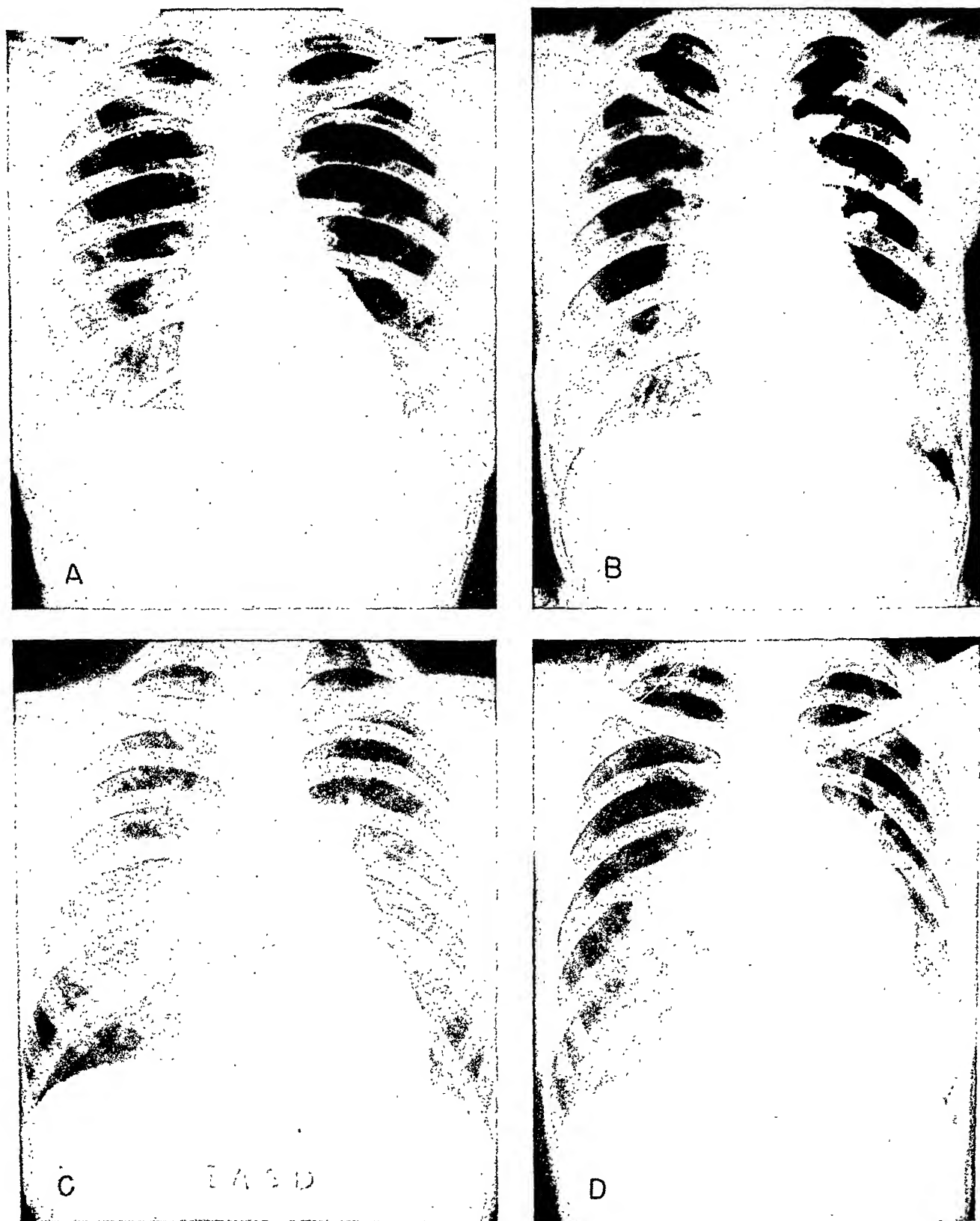


FIG. 1. (A) Roentgenogram to illustrate Grade N+ enlargement of the main pulmonary artery and its hilar and intrapulmonary branches. Because of the wide limits of normal pulmonary artery size, Grade N+ variations are considered as being at the upper limits of normal (Case 13, Table I).

(B) Roentgenogram to illustrate a Grade ++ enlargement of the main pulmonary artery and a Grade +++ enlargement of its hilar and intrapulmonary branches (Case 4, Table III).

(C) Roentgenogram to illustrate a Grade +++ enlargement of the main pulmonary artery and its hilar and intrapulmonary branches (Case 3, Table III).

(D) Roentgenogram to illustrate a Grade ++++ enlargement of the main pulmonary artery and its hilar branches with a Grade ++ enlargement of its intrapulmonary branches (Case 9, Table II).

"main pulmonary artery" refers to a localized convexity or bulge in the left heart border seen immediately beneath the aortic knob. Actually, this convexity is made up of the main pulmonary artery and the proximal portion of its left main branch.^{6,7} Changes in the size and activity of the hilar branches of the artery were also recorded. Hyperactivity of the hilar branches refers to a systolic expansile pulsation of these structures often described as a hilar dance. Changes in the caliber of the intrapulmonary branches of the artery were recorded. To facilitate the interpretation of these changes, a system of grading them was established. Figure 1 illustrates what is meant by N+, ++, +++, and +++++

enlargement of the pulmonary artery and its branches. Inasmuch as the pulmonary artery normally varies greatly in size, particularly in young people, Grade N+ variations are probably best considered as being at the upper limits of normal. Figure 6D illustrates what is meant by a -1 decrease in pulmonary arterial size.

Grading of hyperactivity on the basis of roentgenoscopic observations is admittedly difficult. Grade + has been selected to refer to slight but definite hyperactivity and Grade ++ to refer to more marked changes.

Because this study was carried out in an adult hospital, it did not include infants and young children under nine years. This

TABLE I

THE EFFECT ON THE PULMONARY ARTERY OF A WIDE RANGE OF RESTING FLOWS AT ESSENTIALLY NORMAL PRESSURES

Case Number	Patient	Main Pulmonary Artery		Hilar Branches		Distal Pulmonary Branches—Size	Pulmonary Artery Flow—l/min.	Pulmonary Artery Flow Index l/min./M ²	Pulmonary Artery Pressure Systolic/Diastolic mm. Hg
		Size	Activity	Size	Activity				
Atrial Septal Defect									
1	J.V.	+++	++	++	++	++	34.5	16.3	30/15
2	S.L.	+++	++	++	?	++	16.1	10.3	33/12
3	H.C.	+++	++	+++	++	+++	14.0	7.8	35/10
4	V.C.	++	++	++	?	++	11.0	7.1	32/18
5	B.K.	++	++	N	+	N	11.8	8.6	18/7
6	G.O.	++	N	N+	?	++	27.9	15.1	36/4
7	R.S.	N+	?	N+	?	N+	10.6	6.9	27/8
Patent Ductus Arteriosus									
8	M.C.	N+	+	N+	?	++	10.9	8.5	36/12
9	M.O.	N to ++	?	N+	N	N+	8.0	4.6	22/10
10	E.W.	N+	+	N+	N	N+	9.3	4.8	22/10
11	E.C.	N+	+	N+	?	N	9.1	4.9	38/12
12	T.B.	N+	+	N	N	N	8.9	6.2	25/11
13	E.S.	N+	+	N+	N	N+	5.9	3.3	22/11
14	M.J.	N+	?	N+	?	N+	5.9	3.4	15*
15	E.F.	N+	+	N+	?	N	5.6	2.9	18*
16	H.S.	N+	+	N+	N	N	4.7	3.0	14*
Ventricular Septal Defect									
17	J.H.	N+	N	++	N	++	8.1	9.8	29/12

* Indicates mean pressure.

TABLE II
THE EFFECT ON THE PULMONARY ARTERY OF INCREASED RESTING PRESSURES
WITHOUT SIGNIFICANTLY INCREASED FLOWS

Case Number	Patient	Main Pulmonary Artery		Hilar Branches		Distal Pulmonary Branches—Size	Pulmonary Artery Flow—l/min.	Pulmonary Artery Flow Index l/min./M ²	Pulmonary Artery Pressure Systolic/Diastolic mm. Hg
		Size	Activity	Size	Activity				
Eisenmenger's Complex									
1	M.K.	+++	++	+++	++	++	4.3	3.1	117/54
2	D.K.	+++	+	++	?	++	4.4	2.6	172/54
3	E.B.	+++	?	+++	?	++	7.2	4.4	115/60
4	S.G.	+++	++	++	?	N+	1.0	1.2	96/60
5	C.S.	+++	+	++	+	+++	7.2	4.0	124/64
6	A.G.	++	N	N+	N	++	5.1	3.6	128/81
7	E.G.	N+	N	N+	N	++	3.5	2.2	117/56
8	B.K.	++	N+	++	N	++	3.4	2.3	122/65
Atrial Defect with Pulmonary Vascular Disease									
9*	C.R.	++++	++	++++	++	++	3.0	1.9	80/30
Mitral Stenosis									
10	L.G.	++++	++	++	N	N+	5.4	3.3	97/58
11	M.G.	+++	N	+++	N	++	2.7	2.0	114/58
12	D.V.	+++	N	+++	N	++	3.0	2.7	84/45
13	H.H.	++	N	++	N	N+	4.4	2.2	()
14	J.M.	++	N	+++	N	+++	4.4	2.6	40/16
15	K.O.	++	N	++	N	++	4.9	3.4	118/60
16	J.F.	N	N	N+	N	++	6.5	3.8	40/21
17	J.D.	N	N	N	N	N+	9.4	5.2	37/17
Pulmonary Vascular Disease									
18	L.S.	+++	+	++	+	++	5.0	2.9	87/35
19*	M.Q.	+++	N	N+	N	N+	3.0	2.0	80/55
20*	D.L.	+++	+	++	++	++	3.5	2.5	61/31
21	B.M.	++	N	N+	N	N+	8.1	4.4	59/31
22	R.V.	N+	N	N+	N	N	5.9	3.4	54/30

* Indicates autopsied case.

() Pressure not recorded, markedly elevated.

fact should be borne in mind in assessing the conclusions to be drawn.

OBSERVATIONS

1. *The effect on the pulmonary artery of a wide range of resting flows at essentially normal pressure.* The results of a study of 17 cases showing a wide range of pulmonary arterial flow at essentially normal pressures at rest are summarized in Table

1. Of the 17 cases, 7 had defects in the atrial septum, 1 had a defect in the ventricular septum, and 9 had patency of the ductus arteriosus. Each of these conditions permits shunting of oxygenated blood either directly or indirectly into the pulmonary artery. The artery, therefore, must carry not only its normal complement of blood, but also the additional amount shunted into it.

Table I demonstrates a rather striking correlation between the magnitude of the flow through a pulmonary artery and the recorded size and hyperactivity of that structure. With one major exception, the larger the flow was, the larger and more hyperactive were the main pulmonary artery and its branches. Case 6 was the exception in that despite a very large flow, the main pulmonary artery and its branches were only moderately dilated.

Viewing the results in Table I from a different point of view, it is apparent that of the 9 cases which showed flow indices of



FIG. 2. Increased resting pulmonary artery flow.

Case 1, Table I. J. V., a twenty-one year old veteran of amphibious troop operations was discovered to have a heart murmur at examination for re-enlistment. Cardiac catheter study showed an atrial defect which permitted a huge pulmonary blood flow at normal pulmonary arterial pressures. The roentgenogram shows a Grade +++ enlargement of the main pulmonary artery and its hilar and peripheral branches. Roentgenoscopy revealed marked hyperactive expansile pulsations of the main pulmonary artery and of its hilar branches (hilar dance). Note the size of the pulmonary artery in this case as compared with that in Case 13 (Fig. 1A) where despite the presence of a patent ductus arteriosus the pulmonary artery flow was not large.

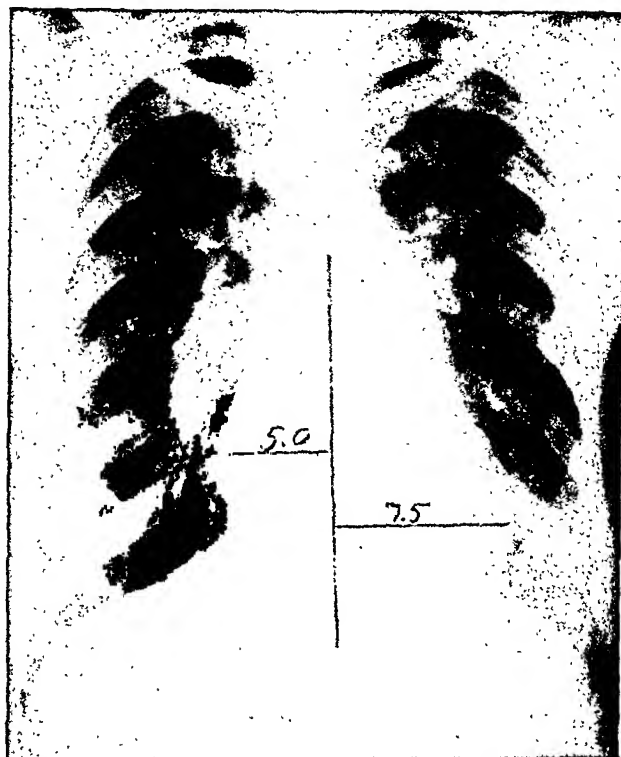


FIG. 3. Increased resting pulmonary artery pressure.

Case 3, Table II. E. B., a thirty-two year old mother, known to have been cyanotic at birth, and limited by dyspnea and fatigue. The digits were clubbed. There was a moderately loud, rough, systolic murmur and a blowing, diastolic murmur in the pulmonic area. The electrocardiogram was characteristic of right ventricular hypertrophy. Cardiac catheterization demonstrated equal systemic and pulmonic arterial pressures, physiologic evidence of an over-riding aorta, as well as small veno-arterial and arteriovenous shunts. The pulmonary blood flow was slightly increased. The roentgenogram shows a +++ enlargement of the main pulmonary artery and its hilar branches with a ++ enlargement of the intrapulmonary branches. Note that the appearance of the pulmonary artery in this case is exactly comparable to that in Figure 2, emphasizing that either increased resting pulmonary artery pressure or flow may produce identical changes.

less than 7 L/min./M², only 1 (Case 9) showed an increase in size of the main pulmonary artery.

On the basis of this study, it would appear that small increases in pulmonary arterial flow rarely produce significant changes in the artery. Larger increases in flow (more than 7 L/min./M²) usually produce enlargement and hyperactivity that are proportional to the size of the flow. These points may be further emphasized

by comparison of Figure 1A (Case 13) with Figure 2 (Case 1).

2. *The effect on the pulmonary artery of increased resting pressures without significantly increased flow.* Twenty-two cases that showed increased pulmonary arterial resting pressures with essentially normal flows are summarized in Table II. The recorded data demonstrate that increased

flows using the routine roentgenographic techniques for study of the pulmonary artery. Comparison of Figures 2 and 3 illustrates this point.

Case 14 is unusual in that there was marked enlargement of the pulmonary artery with only a slight elevation of its pressure.

3. *The combined effect of an abnormal*

TABLE III
THE EFFECT OF AN ABNORMAL INCREASE OF FLOW AND PRESSURE
ON THE PULMONARY ARTERY

Case Number	Patient	Main Pulmonary Artery		Hilar Branches		Distal Pulmonary Branches—Size	Pulmonary Artery Flow—l/min.	Pulmonary Flow Index l/min./M ²	Pulmonary Pressure Systolic/Diastolic mm. Hg.
		Size	Activity	Size	Activity				
Atrial Septal Defect									
1	F.S.	+++	?	+++	++	++	7.5	5.0	83/38
2	R.J.	+++	++	+++	++	+++	28.9	17.4	65/40
3	S.W.	+++	++	+++	++	+++	30.5	19.3	41/21
4	E.Mc.	++	++	+++	N	+++	10.2	7.1	75/29
5	S.Y.	++	+	++	+	+++	12.8	10.5	46/17
Patent Ductus Arteriosus									
6	M.F.	++	?	+++	?	+++	17.0	9.0	60/44
7	M.H.	++	?	++	?	+++	8.8	10.5	48/25
8	S.I.	N+	?	++	?	+++	8.8	10.5	48/30
9	E.M.	N+	N	N+	N	N+	29.3	20.0	45/23
Ventricular Septal Defect									
10	H.B.	+++	++	++	++	+++	8.1	9.8	100/49
11	E.P.	+++	++	+++	+	+++	21.5	15.1	64/36

pressure in the pulmonary artery resulted in an enlargement of that structure which was entirely comparable to that seen in patients with increased flow. This enlargement included not only the main pulmonary artery, but also its hilar and intrapulmonary branches. While hyperactivity was not quite so striking a feature of increased pressure as of increased flow, the fact remains that it may occur and be quite marked. We are unable to distinguish the effects of increased flow with normal pressures from increased pressure with normal

increase of flow and pressure on the pulmonary artery. Eleven cases in which both flow and pressure were elevated in the pulmonary artery are summarized in Table III. These cases differed from those in Table I only in that they had a definite pulmonic hypertension associated with an increased flow.

Since both increased pressure and flow cause enlargement and hyperactivity of the pulmonary artery, it is not surprising to find in Table III the combination of the two producing such a result. Except for

FIG. 4. Increased resting pulmonary artery pressure and flow.

Case 11, Table III. E. P., a twenty-two year old girl with known heart disease from the age of two and a half. Examination revealed a loud precordial systolic murmur with thrill. Right bundle branch block was present. Cardiac catheterization demonstrated an interventricular septal defect which permitted a very large blood flow through the pulmonary circuit, and a high pulmonary arterial pressure. The roentgenogram shows a Grade +++ enlargement of the main pulmonary artery and its hilar and intrapulmonary branches. Roentgenoscopy revealed moderate hyperactivity of the main pulmonary artery and expansile pulsations of the hilar branches. Comparison with Figures 2 and 3 demonstrates that the combination of increased resting pressure and flow in the pulmonary artery results in changes comparable to those of increased pressure or flow alone.



Case 1, flows alone were of sufficient magnitude to account for the recorded changes. In this case, however, the enlargement exceeded that expected from flow alone and probably resulted from the combined effects of both pressure and flow. If the present enlargement were due to a large shunt in the past—and such a shunt probably existed⁸—one would expect, on the basis of experience gained in the ligation of patent ducti, to have a diminution in size of the pulmonary artery along with a

diminution of its flow.⁸ Since this is not the case, it seems reasonable to conclude that both pressure and flow have been operating to produce the present picture. Figure 4 (Case 11) illustrates the changes seen in this group.

4. *The effect on the pulmonary artery of pulmonic stenosis with normal flows distal, to the stenosis.* The 7 cases listed in Table IV were found to have pulmonic stenosis

TABLE IV
THE EFFECT ON THE PULMONARY ARTERY OF PULMONIC STENOSIS WITH
NORMAL FLOWS DISTAL TO THE STENOSIS

Case Number	Patient	Main Pulmonary Artery		Hilar Branches		Distal Pulmonary Branches—Size	Pulmonary Artery Flow—l/min.	Pulmonary Artery Flow Index l/min./M	Pulmonary Artery Pressure Systolic/Diastolic mm. Hg.	Right Ventricle Pressure Systolic/Diastolic mm. Hg.
		Size	Activity	Size	Activity					
1	A.J.	+++	+	N	N	N	5.0	2.9	16/8	80/8
2	W.H.	+++	+	-N	N	-N	5.8	3.5	29/16	38/10
3	W.P.	++	++	N	N	N	7.2	4.6	23/6	39/4
4	T.M.	++	N	N	N	N	5.6	3.1	26/5	40/2
5	R.L.	N+	N	N	N	N	6.9	3.6	33/14	99/2
6	E.R.	N	N	N	N	N	5.3	3.4	22/15	35/6
7	J.Mc.*	N	N	N	N	N	2.8	1.6	28/10	65/0

* Calculated flow believed to be falsely low.

without an associated cardiac abnormality. Four of these 7 cases showed enlargement and definite hyperactivity of the main pulmonary artery. In a fifth case, the pulmonary artery was at the upper limits of normal in size. In none of these 7 cases, however, was there any enlargement or hyperactivity of the hilar or intrapulmonary branches. This dilatation, limited to the main pulmonary artery, seems to be

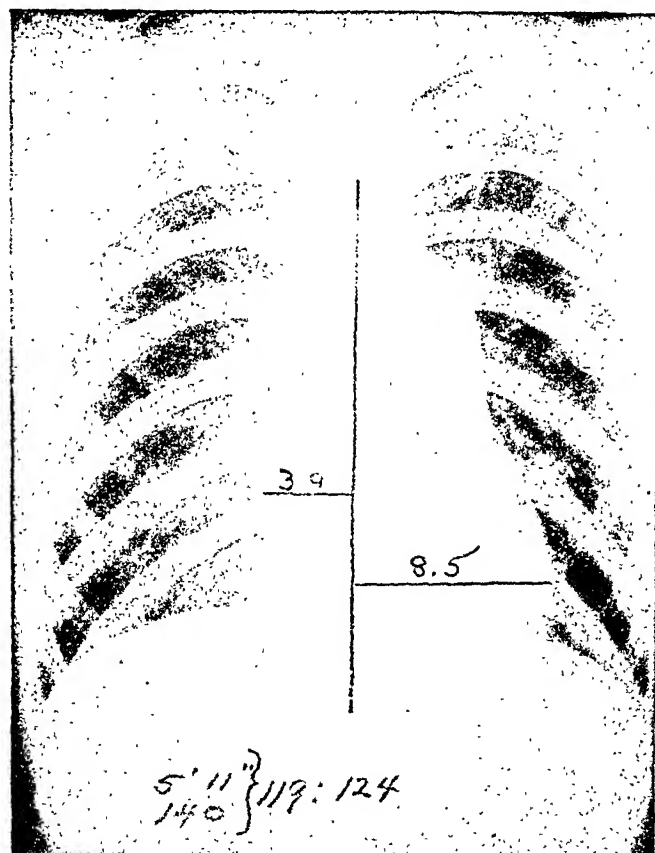


FIG. 5. Pulmonic stenosis with normal pulmonary artery flow.

Case 1, Table IV. A. J., a twenty-three year old male mechanic with heart trouble from the age of five, asymptomatic, but rejected for Army service because of an abnormal cardiac shadow. A loud pulmonic systolic murmur and thrill were present. The electrocardiogram showed right ventricular hypertrophy. A diagnosis of pulmonic stenosis was made on cardiac catheterization with the finding of a normal pulmonary artery pressure and an elevated right ventricular pressure. The blood flows were normal. The roentgenogram shows a Grade +++ enlargement of the main pulmonary artery, but no enlargement of the hilar or intrapulmonary branches. Roentgenoscopy showed hyperactivity of the main pulmonary artery but none of the hilar branches. Normal hilar and intrapulmonary branches distinguish this case from those illustrated in Figures 2, 3 and 4.

a characteristic feature of pulmonic stenosis and usually distinguishes it from a simple increase in flow or pressure (see Table I, Case 5, and Table II, Case 19, for exceptions). It is not, however, an invariable feature because a perfectly definite pulmonic stenosis may exist without producing any recognizable change in the appearance of the pulmonary artery. This fact is amply illustrated by Cases 5, 6, and 7. As regards Case 7, it is believed that the pulmonary blood flow may well have been more normal than calculated and hence this case has been included in this table. The characteristic changes of pulmonic stenosis are seen in Figure 5 (Case 1).

5. *The effect on the pulmonary artery of pulmonic stenosis with reduced flows distal to the stenosis.* The tetralogy of Fallot affords an opportunity to study the effects on the pulmonary artery of a reduced flow distal to a severe pulmonic stenosis. Along with the reduced flow, there is also a reduced pressure in the artery. The results of a study of 12 cases of the tetralogy of Fallot and of 1 case of severe stenosis without dextraposition of the aorta are summarized in Table V.

It has been thoroughly established that the pulmonary artery may be small in the tetralogy of Fallot,¹⁰ and 3 of the cases in Table V showed this change, as illustrated in Figure 6D. Six of the cases, on the other hand, showed no deviation of the appearance of the pulmonary artery from the normal. Cases 1, 2, 3 and 4 showed rather unusual changes. The arteries of Cases 1 and 2 were exactly comparable to those seen in pulmonic stenosis with normal flow (see Fig. 6A and B). Case 1 was a severe pulmonic stenosis with a reduced cardiac output. In Case 2, because of the very small right-to-left shunt, the flow through the pulmonary circuit was essentially equivalent to that in the systemic circuit. In this respect this case resembled a severe pulmonic stenosis in which there was a reduced cardiac output. Case 3 (Fig. 6C) showed a localized saccular aneurysmal dilatation of the left pulmonary artery

and a moderate increase in the size of the intrapulmonary branches. No explanation can be given for these changes. Case 4 showed a small localized dilatation of the main pulmonary artery which did not resemble the changes of pulmonic stenosis. It should be emphasized that the patients in this study have survived to adulthood and cannot, therefore, be expected to resemble

2. Abnormal increases in resting flow of large size (greater than 7 L/min./M²) through the pulmonary artery usually produce changes which are roughly proportional to the size of the flow. These changes consist of an increase in the size and hyperactivity of the artery and its branches.

3. Abnormal increases in pressure in the pulmonary artery at rest result in changes

TABLE V

THE EFFECT ON THE PULMONARY ARTERY OF PULMONIC STENOSIS WITH
REDUCED FLOWS DISTAL TO STENOSIS

Case Number	Patient	Main Pulmonary Artery		Hilar Branches		Distal Pulmonary Branches—Size	Pulmonary Artery Flow— l/min.	Pulmonary Artery Flow Index l/min./M ²	Pulmonary Artery Pressure Systolic/ Diastolic mm. Hg.	Right Ventricle Pressure Systolic/ Diastolic mm. Hg.	Net Right-to-Left Shunt— l/min. mm. Hg.
		Size	Ac-tivity	Size	Ac-tivity						
Pulmonic Stenosis											
1	J.T.	+++	+	—N	N	—N	3.6	2.0	26/9	151/0	0.6
Tetralogy of Fallot											
2	S.K.	+++	+	—	N	—	2.1	2.2	10-20	110/8	0.4
3*	H.G.	N+	N	+++ left N right	N	++	2.0	1.3	()	122/10	1.8
4*	R.M.	N+	N	—	N	—	1.3	1.0	()	()	3.9
5	L.D.	N	N	N+	N	N	2.4	1.3	27/13	90/11	2.1
6*	P.H.	N	N	N	N	N	2.7	2.0	()	97/8	1.8
7	E.E.	N	N	N	N	N	3.5	2.6	15/5	110/0	1.9
8	V.R.	N	N	N	N	N	2.3	1.5	18/8	140/9	2.4
9	D.M.	N	N	N	N	—	1.9	2.2	19/0	110/0	2.2
10	S.F.	—N	N	—N	N	—N	1.1	1.0	7	105/7	1.7
11*	R.D.	—	N	N+	N	N+	3.5	2.3	()	93/6	3.6
12	A.D.	—	N	N	N	N	1.8	1.5	15	140/8	1.7
13	R.A.	—	N	—	N	—	2.4	2.1	18/9	124/8	1.9

* Pulmonary artery not entered.

entirely the severe forms of the tetralogy seen in early childhood.

SUMMARY AND CONCLUSIONS

An analysis has been made of the changes in the pulmonary artery recognizable by routine methods of roentgenography, in known conditions of altered pressure and flow at rest and in intrinsic disease. The results may be summarized as follows:

1. Abnormal increases in resting flow of moderate size (less than 7 L/min./M²) through the pulmonary artery rarely produce a recognizable change.

which are to us indistinguishable from those of increased flow.

4. The combination of an abnormal increase in both pressure and flow at rest produced changes that resemble those of either pressure or flow alone.

5. Pulmonic stenosis with normal pulmonary arterial flow and pressure is usually characterized by a poststenotic dilatation of the artery which in the cases studied was confined to the main pulmonary artery and did not include the hilar or the intrapulmonary branches.

6. Reduced flows beyond a pulmonic stenosis, seen best in the tetralogy of Fallot,

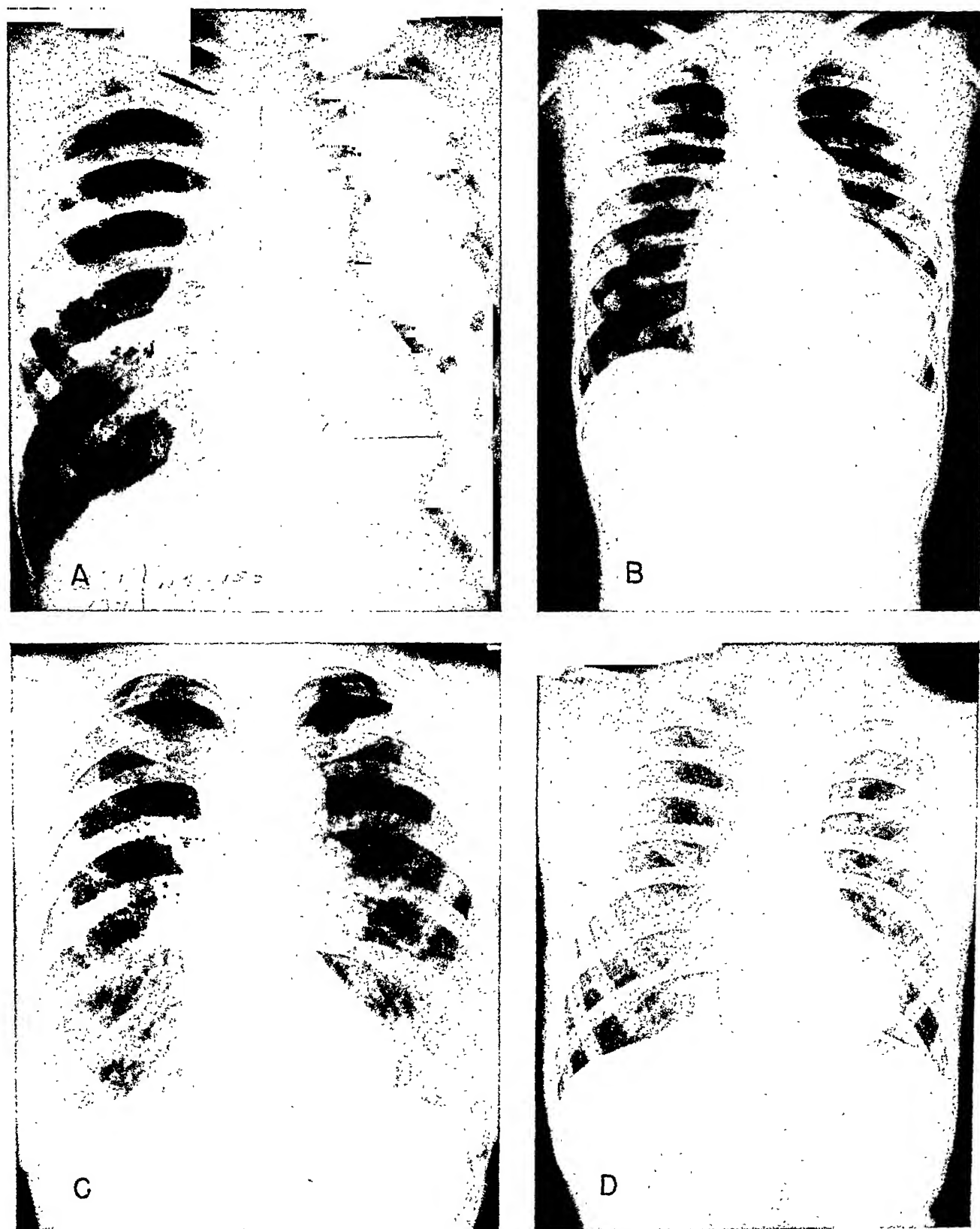


FIG. 6. Pulmonic stenosis with reduced pulmonary artery flow.

(A) Case 1, Table v. J. T., an eighteen year old student with known heart disease at birth. Dyspnea and cyanosis were present with exertion. Cardiac catheterization demonstrated a severe pulmonic stenosis with a reduced pulmonary arterial blood flow. There was arterial oxygen unsaturation due to a small right-to-left shunt. The roentgenogram shows a Grade +++ enlargement of the main pulmonary artery. The hilar and intrapulmonary branches are of less than normal caliber. Roentgenoscopy showed only slight hyperactivity of the main pulmonary artery.

(B) Case 2, Table v. S. K., a nine year old girl who developed bacterial endocarditis with pulmonary

often cause no recognizable change in the pulmonary artery. There may, however, be significant dilatation or reduction in the size of the main artery.

Peter Bent Brigham Hospital
Boston 15, Mass.

REFERENCES

1. DEXTER, L., HAYNES, F. W., BURWELL, C. S., EPPINGER, E. C., SEIBEL, R. E., and EVANS, J. M. Studies of congenital heart disease. I. Technique of venous catheterization as a diagnostic procedure. *J. Clin. Investigation*, 1947, 26, 547-553.
2. DEXTER, L., HAYNES, F. W., BURWELL, C. S., EPPINGER, E. C., SAGERSON, R. P., and EVANS, J. M. Studies of congenital heart disease. II. Pressure and oxygen content of blood in the right auricle, right ventricle, and pulmonary artery in control patients, with observations on the oxygen saturation and source of pulmonary "capillary" blood. *J. Clin. Investigation*, 1947, 26, 554-560.
3. DEXTER, L., HAYNES, F. W., BURWELL, C. S., EPPINGER, E. C., SOSMAN, M. C., and EVANS, J. M. Studies of congenital heart disease. III. Venous catheterization as a diagnostic aid in patent ductus arteriosus, tetralogy of Fallot, ventricular septal defect, and auricular septal defect. *J. Clin. Investigation*, 1947, 26, 561-576.
4. HAMILTON, W. F., BREWER, G., and BROTMAN, I. Pressure pulse contours in the intact animal; analytical description of a new high-frequency hypodermic manometer with illustrative curves of simultaneous arterial and intracardiac pressures. *Am. J. Physiol.*, 1934, 107, 427-435.
5. VAN SLYKE, D. D., and NEILL, J. M. Determination of gases in blood and other solutions by vacuum extraction and by manometric measurement. *J. Biol. Chem.*, 1924, 61, 523-573.
6. ROBB, G. P., and STEINBERG, I. Visualization of the chambers of the heart, the pulmonary circulation, and the great blood vessels in man; practical method. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 1-17.
7. CHAVEZ, I., DORBECKER, N., and CELIS, A. Direct intracardiac angiocardiology; its diagnostic value. *Am. Heart J.*, 1947, 33, 560-593.
8. Unpublished observations.
9. DONOVAN, M. S., NEUHAUSER, E. B. D., and SOSMAN, M. C. Roentgen signs of patent ductus arteriosus; summary of 50 surgically verified cases. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 293-305.
10. TAUSSIG, H. B. Congenital Malformations of the Heart. The Commonwealth Fund, New York, 1947.



emboli. There was slight digital clubbing and cyanosis. A widely transmitted precordial systolic murmur and thrill were present. The electrocardiogram showed marked right ventricular hypertrophy. Cardiac catheterization revealed a severe pulmonic stenosis with low pulmonary arterial pressure and reduced pulmonary blood flow. A small right-to-left shunt was present. The roentgenogram shows a Grade +++ enlargement of the main pulmonary artery with a reduction in the caliber of the hilar and intrapulmonary branches.

(C) Case 3, Table v. H. G., a thirty-six year old woman cyanotic from birth and troubled by dyspnea. The cardiac catheter passed directly into the aorta from the right ventricle. The blood flow through the lungs was low and there was moderate arterial oxygen unsaturation due to a moderate right-to-left shunt. The roentgenogram shows a double arched aorta, a saccular dilatation of the left hilum and an increase in caliber of the intrapulmonary branches. Roentgenoscopy gave no additional information.

(D) Case 13, Table v. R. A., a twelve year old boy with known heart disease and cyanosis since birth. A loud blowing systolic murmur was heard over the precordium. Catheterization findings were typical of the tetralogy of Fallot. There was a low pulmonary artery flow. The roentgenogram shows a definite reduction in the size of the main pulmonary artery and of its branches.

THE FATE OF OIL PARTICLES IN THE LUNG AND THEIR POSSIBLE RELATIONSHIP TO THE DEVELOPMENT OF BRONCHIOGENIC CARCINOMA*

By L. R. SANTE, M.D.

ST. LOUIS, MISSOURI

THE deleterious effect produced by the injection of certain oils into the lung has long been recognized; the roentgenological appearance of the pulmonary reaction is well known; certainly, at the present time, it is the exceptional case where detrimental oily material is prescribed by a physician as medication for the nasal or air passages. It is the purpose of this paper to emphasize a less obvious method by which oil may gain entrance into the lung and another, more remote, but even more serious possible consequence of its aspiration.

Guieysse-Pellissier¹² in 1920 examined the effect of injection of olive oil into the lungs of dogs and rabbits. According to his observation, droplets of oil present in the alveoli were engulfed by large mononuclear cells. The oily droplets were thus removed from the alveoli by phagocytosis without inflammation, leaving the lung structure unharmed. The olive oil used in his experimental investigation was undoubtedly highly refined and free from fatty acids. Other oils, chaulmoogra oil, olive oil, and liquid petrolatum, injected into the lungs of rabbits remained much longer in the lungs and caused "proliferative bronchopneumonia" (Corper and Freed⁵).

In 1927, Pinkerton¹⁸ reported 6 similar cases in detail, describing the lung picture and discussing the nature of the reaction. He discussed the possibility of endogenous origin of the oily material from body fats but came to the conclusion that, "These facts together with the nature of the reaction on the part of the lung, all seem to substantiate the exogenous origin of the ma-

terial much better than its endogenous origin."

It was left for Pinkerton,¹⁹ in 1928, through experimental investigation, to determine the character of the reactions to various types of oily substances, vegetable, animal, and mineral, and to establish the criteria for an innocuous, safe oily substance as a vehicle for medication introduced into the lung.

The intratracheal injection of iodized oil (lipiodol, lipiodine or iodochloral) for bronchography is a procedure which has been rendered safe and has been carried out without hesitation by radiologists and other physicians for many years without ill effect. All of these preparations have vegetable oil bases (poppy seed oil, oil of sesame, etc.), and are free from fatty acids. Microscopic examination of the lung tissues for prolonged periods fails to show evidence of irritation or inflammation. Pinkerton's observation that these highly refined vegetable oils, free from fatty acids, do not cause inflammation reaction in the lungs, has been borne out clinically by years of use by physicians.

The opaque character of the iodized oil, however, permits observation upon the method of its entrance into the finer structures of the lung, its distribution and its final absorption and elimination. It is reasonable to suppose that the sequence of events observed with the entrance of iodized oil into the lung are duplicated in a similar fashion on the introduction of other non-opaque oils (Sante²²). After intratracheal injection, the oil passes by gravity

* From the Department of Radiology of St. Louis University School of Medicine. Presented at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14-17, 1948.

into the smaller bronchioles. At this point it is hampered in its passage into the finer lung structures by the capillary size of the tubules, the air remaining in the alveoli, and the viscosity of the oil. Immediately after introduction, the oily substance fills the bronchial tree down to the finer bronchioles, but the alveoli still remain free. After a few minutes, in the normal lung, the oil passes from the bronchioles into the alveoli leaving only remnants of the oil clinging to the walls of the bronchioles to outline their positions. The passage of the oil into the alveoli is facilitated not only by gravity and normal respiration or coughing, but also by the absorption of air from the obstructed air sacs, the oil constituting a plastic foreign body which is sucked in as the air is absorbed. The feathery appearance of the oil as seen in the alveoli is due to partial filling of the air cells; many remain entirely free from any of the oily material. This is due to the fact that the volume of the bronchioles is much less than that of the alveoli with which they communicate. If, as was frequently done in the early days, the bronchi are heavily cocaineized, the cough reflex will become abolished and the bronchi will dilate. Under these conditions the bronchi become large reservoirs of oil which passes into and completely fills the alveolar structures, giving rise to the roentgenographic picture, often referred to as "drowned lung." To avoid this in our present-day examinations, only a small amount of anesthetic is sprayed on the throat or the examination is made without local anesthesia.

What is the fate of *vegetable oil* thus introduced into the lung? Within a short time any oil remaining in the bronchial branches is coughed up and expectorated, leaving only the feathery deposits of oil in the alveoli. Once foreign material has entered the air sacs it cannot be removed by coughing or ciliary action; only by the action of phagocytic cells can each small particle be carried away into the lymphatics. It may require many months for the last roentgenologic evidence of the radiopaque

oil to disappear from the parenchyma.

Microscopic examination of the lung tissue reveals the oil droplets within the alveolar structures. Enormous macrophages give the appearance of signet rings as they surround and engulf the droplets of oil. By this means the oil is removed from the alveoli and carried off by the lymphatics. Autolysis of the oil is followed by complete absorption and removal. Long after all evidence of lipiodol has disappeared from the roentgenogram, oil droplets can be found on microscopic examination. In time, every vestige of oil will disappear without evidence of damage to the lung structures. Microscopically, little, if any inflammatory reaction can be seen with vegetable oils such as those used in lipiodol. This is probably due to the complete freedom of these oils from fatty acid. Deteriorated oil, therefore, should never be used because of the possibility that it might develop fatty acids which cause irritation and damage to the lung. A bottle, once opened, should never be used for subsequent examination; any change in color is likewise evidence of deterioration.

Let us consider now the effect of *animal oils*, such as cod-liver oil, upon the lung. Having demonstrated by roentgen-ray and subsequent microscopic examination, the method by which lipiodol gains entrance into and is finally eliminated from the lung, it is logical to assume that other oils may follow a similar course. Microscopic examination of the lung, after injection of cod-liver oil, would indicate that the oil finds its way to the alveoli in a manner similar to that observed with lipiodol. Once it reaches the air cells, however, it remains for a long period of time before it can be effectively removed by phagocytosis. Even when fresh, cod-liver oil contains a high percentage of fatty acids; its position in the alveoli, subject to the ebb and flow of air during respiration, favors oxidation and deterioration. The oil becomes stringy and sticky and large amounts of fatty acid are formed. As a result, the sojourn of animal oils in the lung is accompanied by

an intense inflammatory reaction and extreme fibrosis. There is marked cellular infiltration of the surrounding lung structures and large multinucleated foreign body giant cells make their appearances. A pneumonic process develops with high fever, rapid respiration and pulse with varying degrees of collapse of the patient. The quantity of animal oil, the amount of fatty acid which it contains, and the presence or absence of bacterial infection influence the severity of the reaction. Such an inflammatory process is spoken of as lipoid pneumonia. It may be fatal.

The acute pneumonic reaction following aspiration of *liquid petrolatum* into the

lungs was first pointed out by Laughlen¹⁵ in 1925. A peculiar histopathological picture was noted, the consolidation of the lung tissue being caused largely by accumulations of oil-laden phagocytes and inflammatory cells from the attendant infection.

Pinkerton¹⁸ in 1927 reported multiple firm fibrous nodules in the lung consisting of globules of liquid petrolatum (mineral oil) imbedded in dense fibrous tissue. These tumor-like masses he called "paraffinomas."

Ikeda,¹³ ten years later, pointed out that lesions resulting from aspiration of oil or fatty material into the lung fall into two

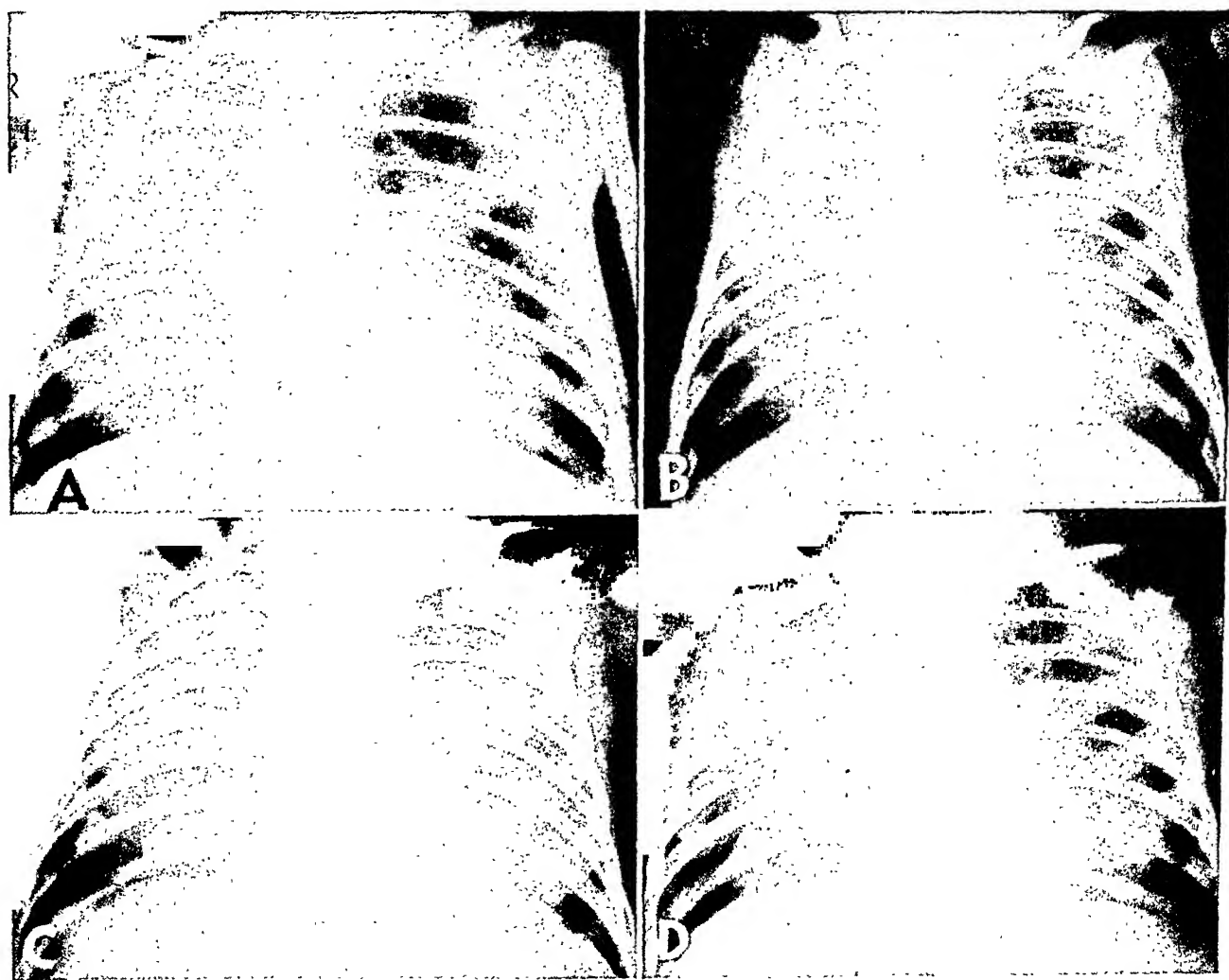


FIG. 1. Acute lipoid pneumonia, following administration of a tablespoonful of mineral oil twice daily for a two week period to an infant two weeks old. Note the diffuse homogeneous appearance of the pneumonic reaction throughout the lungs, extending to the peripheral structures. There was very little change in appearance over a period of two months (A, B, C, D) and the infant did not recover. The degree and seriousness of the reaction depends upon the amount of oil aspirated into the lung, and the rate at which it is delivered.

groups: one the *acute lipoid pneumonia* or *infantile type*, and the other the *chronic granulomatous infiltration* or the *adult type*. Since either type of lung reaction may occur in infants or adults, it would seem more logical to dispense with the age factor and designate the two types as acute or chronic with the types of lung reaction seen in each. More recent considerations of the subject would seem to bear out these observations.^{6,7,14,21,23}

Mineral oil also may cause havoc in the lung, but not from the same cause, and not with the same reaction. Once in the alveoli it cannot escape except by emulsification and the action of phagocytic cells. Within the cell and in the lymphatics its behavior is different. Being inert, it cannot readily be autolyzed by the cells and it is carried with little change through the regional lymphatics to the hilum. It excites an extreme degree of cellular reaction which results in fibrosis and scar tissue which is dense and hard from contraction and becomes almost acellular. The phagocytic

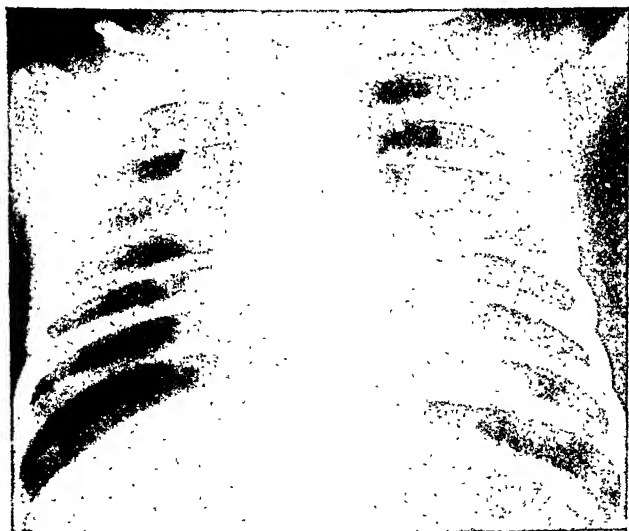


FIG. 2. Acute lipoid pneumonia, resulting from administration of a large amount of mineral oil delivered to an infant over a much longer time, many months, used in nose drops. Note the shaggy appearance of the infiltrated area within the central zone, leaving the peripheral zone clear. This indicates clearing of the alveolar structure and transportation of the oily material by the lymphatics to the hilar regions; it is a favorable sign for recovery but does not mean that the oil will be eliminated from the body.



FIG. 3. Acute lipoid pneumonia in an older individual from aspiration of mineral oil taken by mouth. The acute form is the type usually seen in infants but it may occur in older children and adults also. Note pneumonic consolidation in lower portion of right lung.

cells themselves may be destroyed by the indigestible oil which they contain. Such a mass of paraffin oil droplets enmeshed in heavy scar tissue gives rise to a "paraffinoma." These may attain several centimeters in diameter. They usually cluster about the large bronchial branches near the root of the lung at the site of the hilar lymph nodes—indeed, it is a question whether or not they may not even replace the lymphoid tissue of the node from pressure atrophy.

Such lipoid material may pass through the hilar nodes and into the thoracic duct entering the systemic circulation (Pinkerton and Moragues,²⁰ Young, Applebaum and Wasserman²⁴). Oil deposits have been found in the liver, spleen, and other organs of the body. Once mineral oil gains entrance into the alveoli, it is a question whether it is ever eliminated; being an inert material incapable of saponification, it resists all efforts of the phagocytes to digest it. Since it cannot be eliminated, it is evident that small amounts, if added daily, will accumu-

late to produce larger deposits in the lungs.^{1,9} Numerous other cases of this sort have been reported.^{2,4,8,10,11,16}

Differential diagnosis of lipoid pneumonia and pulmonary neoplasm may be difficult or impossible.³ A method has been devised for the aspiration biopsy diagnosis of lipoid pneumonia.¹⁷

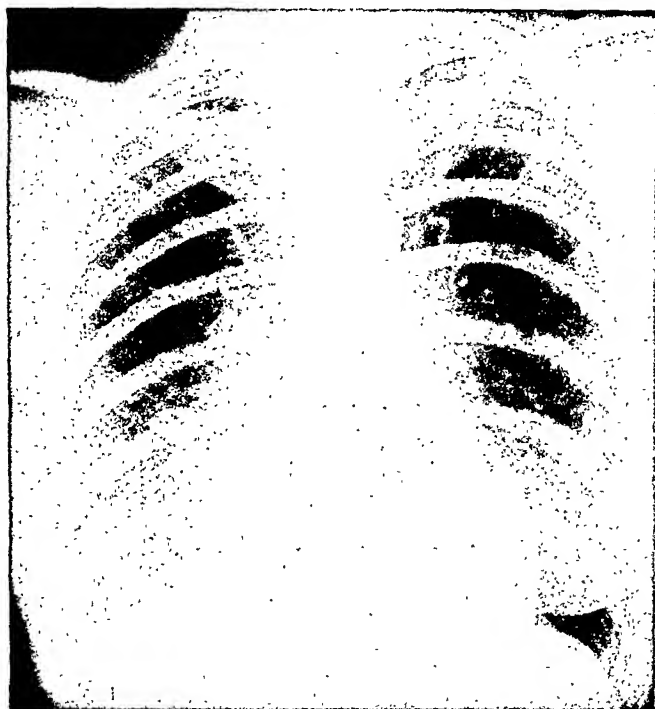


FIG. 4. Chronic type in adult showing the nodular appearance of the inflammatory process near the right hilar region, with the parenchymal portion of the lung relatively free. The patient had used mineral oil in nose drops for many years.

One would think that such paraffinomas would be innocuous once they had reached this stage, but this is far from true. They may, by pressure on larger bronchi, produce partial obstruction resulting in bronchiectatic dilatation; they may produce local inflammation and erosion, or, which seems to be of particular interest, they may be the basis for the development of bronchiogenic carcinoma. Carcinomatous tissue itself may have an appearance so grossly similar to a paraffinoma that the association of the two conditions may be entirely overlooked, unless a number of sections are taken from different areas of the tumor mass. Pinkerton,¹⁹ in his earlier investigation (1928) had a similar impression of the possible relationship of oily substances in

the lung to the development of epitheliomas as indicated by his statement, "Epithelium may participate in the repair of a suddenly produced area of necrosis in the lung, and, in so doing, may take on an almost neoplastic activity."

Our attention was drawn to the subject by the findings seen in 2 patients who died from bronchiogenic carcinoma. In one case, a large paraffinoma apparently formed the basis for the development of the carcinomatous growth. In the other case, lipoid pneumonia with early organization was present, and the association of the two lesions seemed probable. In both instances, the history of the use of mineral oil was obtained from the families after autopsy had disclosed the presence of paraffinomas of the lung.

If the microscopic appearance of paraffinoma is constantly borne in mind it may be possible that its association with the development of bronchiogenic carcinoma will prove a more frequent observation.

In ordinary microscopic preparations the fat globules appear as vacuolated areas; the fat itself is dissolved by the xylol used in preparing the specimen. In order not to lose the fat globules, all sections must be made by the frozen section method. Staining with sudan III causes the fat globules to stain bright red. If there is a question of identifying mineral oil as the fatty agent, the use of osmic acid will serve for its differentiation; osmic acid will not be influenced by mineral oil, but with all other oils it will turn black.

REPORT OF CASES

CASE 1. C. D., white male, aged sixty-two, was admitted to St. Mary's Hospital, January 7, 1947.

Family History. There was nothing of significance in the family history; no history of cancer in the family.

Past History. The patient had the usual diseases of childhood. He had never had any previous chest disease of any sort, no pneumonia, tuberculosis, bronchiectasis. No mention was made and no questions were asked concerning the use of mineral oil in any form.

Present Illness. The chief complaint on entrance was weakness, cough, mucoid expecto-

ration, and a dull pain in the lower portion of the right chest. The patient attributed his trouble to an attack of influenza which occurred about two months before entrance. Onset was with cough, fever, mucoid expectoration, and pain in the right lower chest. There was never any blood in the sputum. The fever rapidly subsided but the other symptoms continued up to the present time. The patient had lost 20 pounds in weight.

Mudd and a total pneumonectomy was performed. A diffuse infiltrating tumor mass, 10 cm. in diameter, was found in the upper portion of the right upper lobe.

Pathological Examination. The tumor was firm and the cut surface yellowish tinged with grayish-white tissue. The bronchus was thickened but not occluded.

Microscopic Examination. The architecture of the lung is destroyed and replaced in some areas

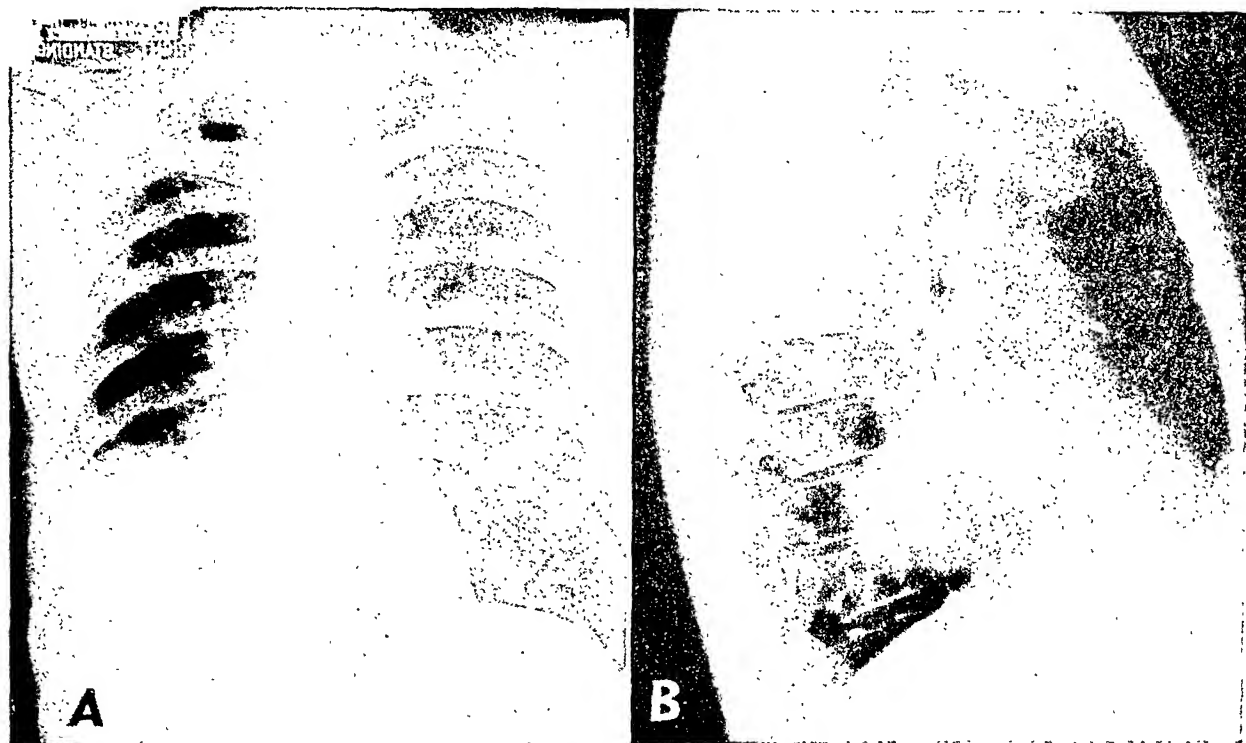


FIG. 5. Case 1. (A) Large rounded, well defined mass in lower portion of right lung field. (B) Lateral view showing location and isolated character of the mass. Correlation with the clinical history resulted in diagnosis of bronchiogenic carcinoma. Pneumonectomy specimen showed the malignant growth but association of mineral deposits in the lung. Subsequent questioning of his roommate from the institution in which he was employed disclosed the fact that he had taken mineral oil in ounce doses just before retiring for at least seven years.

Physical Examination. Physical examination disclosed impaired resonance over the lower portion of the right lung and there was some impairment on percussion but no rales. The heart was normal in rate and rhythm. There was, however, pitting edema of the lower extremities to the knees, indicating some impairment of the circulation.

Roentgen examination disclosed an oval 6 by 8 cm. mass in the right hilum region extending outward into the lung. In view of the clinical symptoms it was thought that this was due to a bronchiogenic carcinoma.

Bronchoscopy was performed but nothing abnormal could be detected.

Laboratory findings were not significant.

The patient was operated on by Dr. J. L.

by highly malignant epithelial tumor tissue. The epithelial cells are growing in sheets and cords and show marked anaplasia, pleomorphism, and hypochromatism with many atypical mitoses. In other areas the picture is that of organizing pneumonia with many vacuolated cells in the alveoli. The alveolar walls contain large vacuoles which undoubtedly represent oil droplets. In a few areas the architecture of the lung is destroyed and replaced by dense fibrotic tissue, in which oil droplets are embedded. The picture in these areas is that of an organizing lipid pneumonia or paraffinoma. Sections from the central portion of the mass showed a combined picture of paraffinoma and carcinoma, while peripherally the picture was that of pure carcinoma. The entire picture suggests that the

carcinoma present may have arisen in a long-standing area of organized lipid pneumonia. There is much lymphoid tissue in all sections of the lung. A section of a large bronchial lymph node shows marked hyperplasia and anthracosis but no metastatic tumor is seen. Diagnosis: (1) bronchiogenic carcinoma; (2) paraffinoma of lung.

The patient had a stormy postoperative period. Repeated transfusions were given to-

There was no acute distress. There was some emphysema; expansion was limited but equal. Breath sounds were accentuated in the lower lobe right posterior but no rales could be heard.

Roentgen examination revealed a mass in the right lung, which in view of the clinical symptoms it was felt was due to bronchiogenic carcinoma. The left lung was free.

None of the *laboratory findings* were of particular significance in the case; urine and

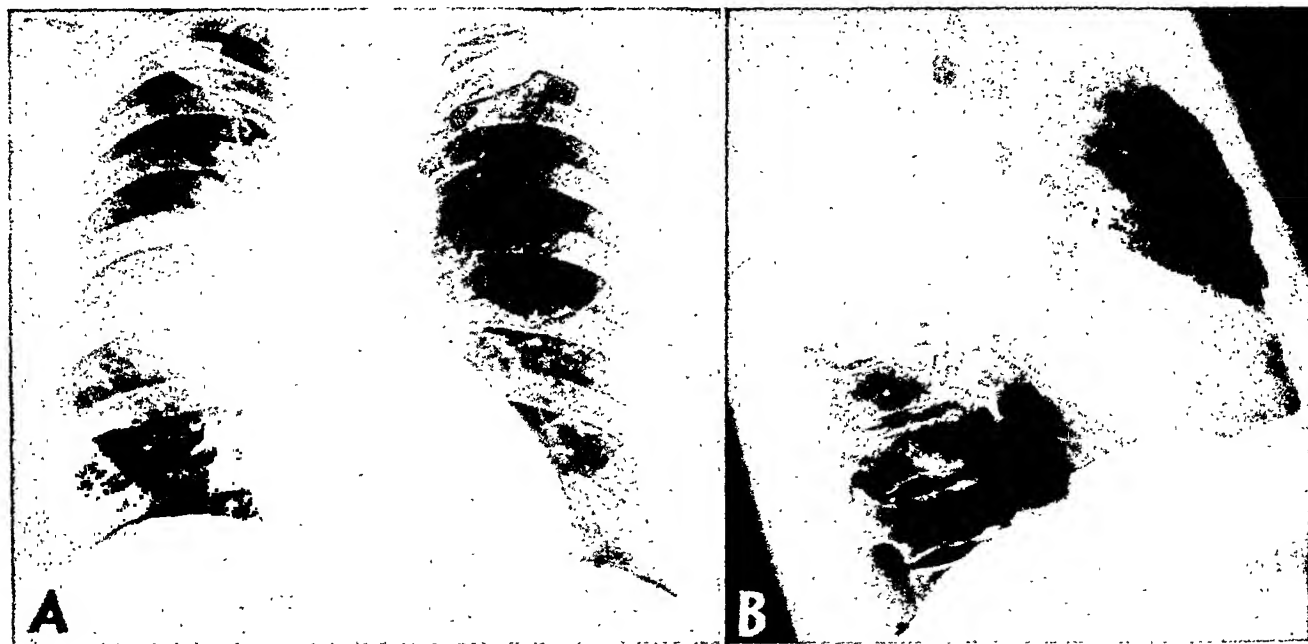


FIG. 6. Case 11 (A) Large rounded, nodular mass in right hilar region extending out into lung field. (B) Lateral view disclosing position and size of mass. Correlation with clinical history resulted in diagnosis of bronchiogenic carcinoma. Pneumonectomy specimen and subsequent autopsy showed large paraffinoma at hilum with superimposed bronchiogenic carcinoma. Subsequent history from his employer and relatives disclosed his use of mineral oil as a laxative in tablespoonful doses on retiring for "many years."

gether with stimulants, oxygen inhalation and digitalization for a failing circulation, all to no avail, and the patient died on January 24, 1947.

At autopsy there were no other significant findings.

CASE 11. M. L., white male, aged sixty-three, entered St. Mary's Hospital, St. Louis, Missouri, February 16, 1947.

Past History. On a previous hospital admission for appendectomy it had been discovered by roentgen examination that there was a mass in the right chest. There was a history of chronic cough for one year, slight expectoration but no hemoptysis, and pain in the chest. There was never any fever or signs of inflammation but merely an insidious progression of the disease and loss of 20 pounds in weight.

Physical examination was not conclusive.

sputum failed to show any positive findings; the serology was negative.

Biospy secured by *bronchoscopic examination* confirmed the diagnosis of bronchiogenic carcinoma. Following the bronchoscopic examination the patient had repeated attacks of hemoptysis for the next two weeks. He finally recovered sufficiently for operative procedure and pneumonectomy was performed.

Blood transfusions, nasal oxygen inhalation, penicillin and stimulants were given; within a few weeks the patient recovered and was discharged.

Pathological Examination. The specimen consists of the right lung having a rather firm necrotic mass in the lower lobe measuring 7 by 8 by 1 cm. in size. The necrotic area was found to be surrounded by a grayish, somewhat friable, irregular mass of tissue invading the greater

portion of the lower lobe. A lymph node was found at the hilum. Near the lower edge of the lower lobe, the lung tissue is light red in color, and a creamy yellow pus-like exudate can be expressed from the smaller bronchi. The upper and lower lobes show moderate crepitation and on section are a dull reddish brown color.

Microscopic examination. Partial destruction of the lung architecture has taken place. Masses and strands of very anaplastic, pleomorphic, hyperchromatic cells are seen having many mitotic figures; in many instances keratin pearl formation has taken place. In many areas the alveoli and alveolar walls are filled with large vacuolated mononuclear cells and many multinucleated giant cells of the foreign body type are present. Areas are present adjacent to partially necrotic regions that show spiculated structures within giant cells. Fibrosis adjacent to these areas is present but not marked. Scharlach R stains reveal that the large mononuclear cells seen in the alveolar walls and alveolar spaces are laden with oil or fat. The picture seen aside from carcinoma is that of lipoid pneumonia in the early stages of organization. Whether the carcinoma arose as a result of the lipoid pneumonia is a debatable issue in this case. The possibility that the lipoid material originated from necrotic tumor tissue cannot be excluded, but seems remote. The possibility that the picture is a reaction to lipiodol is excluded by the history. Acid-fast stains are negative. Diagnosis: (1) bronchiogenic carcinoma (squamous cell type); (2) lipoid pneumonia, with early organization.

Comment. Subsequent inquiry in both of these cases from relatives and friends disclosed that fact that they had taken mineral oil for years as a laxative, a tablespoonful or so, just before retiring. No history could be obtained of its use in any other form. The fact that small quantities of lipiodol, instilled into the nasopharynx during sleep can be demonstrated at subsequent roentgen examination in the bases of both lungs, is indication that mineral oil, especially when taken just before retiring, might gain entrance into the lungs in this way. The lack of saponification of mineral oil makes its ultimate absorption and assimilation doubtful so that oil aspiration in this manner, even if in small quantities daily,

might accumulate to form a collection of sufficient size to give trouble in the lungs.

Many hydrocarbons are known to be carcinogenic agents. It behooves both radiologists and pathologists, therefore, to be constantly on the lookout for evidence of such an association. If this proves to be the case, then it is obvious that mineral oil in any form as a vehicle or for medication should be used with great caution for any purpose in the body.

SUMMARY

1. Highly refined vegetable oils, free from fatty acids such as those used in iodized oils in common use, do not produce any evidence of inflammatory reaction when injected into the lung and are ultimately completely eliminated without evidence of damage to the lung structures. When spoiled or rancid, however, even vegetable oils may become irritating and should not be used for injection into the lung.

2. Animal oils, owing to their high fatty acid content, are extremely irritating, producing lipoid pneumonia which may be fatal. If recovery occurs, however, the oily particles may be completely eliminated.

3. Mineral oil also produces damage when ingested into the lung, but this is from another cause; the oil itself cannot be saponified and therefore cannot be digested by the phagocytes, and the oily droplets thus remain. Accumulation of such droplets surrounded by dense walls of fibrous tissue are called paraffinomas.

4. Two cases of bronchiogenic carcinoma are reported, one of which undoubtedly was in pre-existing paraffinomas. In the other case, lipoid pneumonia was present, but the lesion was in an earlier stage, and its etiological relationship to the malignant lesion is less definite.

I am deeply indebted to Dr. Henry Pinkerton, Professor of Pathology and to Drs. V. Moragues and G. S. Saccomanno of the Pathology Department of St. Louis University School of Medicine, for the pathological material used in preparing this paper.

606 Missouri Bldg.
St. Louis, Mo.

REFERENCES

1. BISHOP, G. G. C. Oil aspiration pneumonia and pneumolipoidosis. *Ann. Int. Med.*, 1940, 13, 1327-1359.
2. BROMER, R. S., and WOLMAN, I. J. Lipoid pneumonia in infants and children. *Radiology*, 1939, 32, 1-7.
3. BROWN, A. L., and BISKIND, G. R. Differential diagnosis between lipid pneumonia and pulmonary neoplasm. *J.A.M.A.*, 1941, 117, 4-6.
4. CANNON, P. R. Problem of lipid pneumonia. *J.A.M.A.*, 1940, 115, 2176-2179.
5. CORPER, H. J., and FREED, H. Intratracheal injection of oil for diagnostic and therapeutic purposes. *J.A.M.A.*, 1922, 79, 1739.
6. EVAN, R. Lipoid pneumonia of adult. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1947, 63, 78-80.
7. FACQUET, J., and LANGEARD, MME. Pulmonary opacities of middle lobe in singers, two cases (probably oil pneumonia). *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1947, 63, 200-204.
8. FREIMAN, D. G., ENGELBERG, H., and MERRIT, W. H. Oil aspiration (lipoid) pneumonia in adults; clinicopathologic study of 47 cases. *Arch. Int. Med.*, 1940, 66, 11-38.
9. GARVIN, C. F. Lipoid pneumonia. *Arch. Int. Med.*, 1939, 64, 586-589.
10. GOODWIN, T. C. Lipoid cell pneumonia. *Am. J. Dis. Child.*, 1934, 48, 309-326.
11. GRAEF, I. Studies in lipid pneumonia; lipid pneumonia due to cod liver oil; lipid pneumonia due to liquid petrolatum. *Arch. Path.*, 1939, 28, 613-667.
12. GUIEYSSE-PELLISSIER, A. Recherches sur l'absorption de l'huile dans le poumon. *Compt. rend. Soc. de biol.*, 1920, 83, 809.
13. IKEDA, K. Lipoid pneumonia of adult type (paraffinoma of lung). *Arch. Path.*, 1937, 23, 470-492.
14. KOOPERSTEIN, S. I., and BASS, H. E. Pulmonary reaction following intrabronchial instillation of lipiodol in bronchial asthma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 56, 569-576.
15. LAUGHLIN, G. F. Pneumonia following nasopharyngeal injections of oil. *Am. J. Path.*, 1925, 1, 407-414.
16. MOEL, M., and TAYLOR, H. K. Oil aspiration pneumonia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 177-184.
17. NATHANSON, L., FRENKEL, D., and JACOBI, M. Diagnosis of lipoid pneumonia by aspiration biopsy. *Arch. Int. Med.*, 1943, 72, 627-634.
18. PINKERTON, H. Oils and fats; their entrance into and fate in the lungs of infants and children. *Am. J. Dis. Child.*, 1927, 33, 259-285.
19. PINKERTON, H. Reaction to oils and fats in the lung. *Arch. Path.*, 1928, 5, 380-401.
20. PINKERTON, H., and MORAGUES, V. Paraffinoma of the lung with secondary tubercle-like lesions in liver and spleen. *Arch. Path.*, 1940, 29, 691-699.
21. REWELL, R. E. Lipoid pneumonia; pitfall in diagnosis. *Brit. M. J.*, 1947, 1, 409-411.
22. SANTE, L. R. Practical observations on the use of iodized oil in bronchography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1934, 32, 762-768.
23. SCHOCH, E. O. Harmfulness of preparations containing paraffin and vaseline. *Monatschr. f. Krebsbekämpf.*, 1943, 11, 31.
24. YOUNG, A. M., APPLEBAUM, H. S., and WASSERMAN, P. B. Lipoid pneumonia. *J.A.M.A.*, 1939, 112, 2406-2409.

DISCUSSION

DR. JOHN R. McDONALD, Rochester, Minn. I have certainly enjoyed this very stimulating paper by Dr. Sante and appreciate the opportunity to discuss it.

Mineral oil granulomas are seen in many parts of the body. As far as I know, there is no evidence to support the carcinogenic properties of mineral oil. I have never seen any evidence of malignant transformation in a mineral oil granuloma.

Lipoid granulomas may be divided into three types according to the type of lipid material causing the granuloma. These lipids are the mineral oils, vegetable oils and animal oils. In my experience, lipid pneumonitis is a very common disease. Lipoid changes can be seen in the lung in practically any chronic suppurative condition. The lipid that becomes apparent in suppurative conditions is the result of cellular breakdown in which the lipid materials, which are ordinarily not visible in the cell, become visible. This condition is seen not only in the lung but in suppurative processes throughout the body. For instance, it is very common in chronic pyonephrosis of the kidneys for the necrotic regions to be yellowish, and histopathologic examination of these regions will reveal many lipophages. As an example of an endogenous lipid pneumonia, I should like to give data on 1 case in which a resected lower lobe of a lung revealed bronchiectasis and yellowish consolidation. Histopathologic examination revealed many lipophages, and chemical examination revealed that the lipid content of the lung was 4.1 per cent total lipid (wet weight). This was made up of 2.9 per cent cholesterol, 1.4 per cent cholesterol ester, 5.3 per cent lecithin and 1.2 per cent fatty acid. In other words, this lipid was definitely endogenous.

Furthermore, this man had no history of ever having taken nose drops.

It is often possible to find lipoid changes in the obstructive pneumonitis secondary to a carcinoma of the bronchus or any other obstruction to the bronchus. This also, in my experience, has proved to be endogenous.

I should also like to show another example of lipoid pneumonitis in which the inciting agent was iodochlorol as used in bronchography. The vehicle in this particular substance is peanut oil. In this case, the proof that this sub-

stance was iodochlorol was obtained by doing chemical analysis of the granulomatous region in comparison with a normal region of the same lung. In this particular instance the granulomatous region showed 300 times the content of iodine that the nongranulomatous region did. In my opinion, gross chemical methods are much more accurate for the determination of a specific lipid material than are histopathologic stains. Furthermore endogenous lipoid pneumonitis is much more common than exogenous lipoid pneumonitis.



A CASE OF BILATERAL PNEUMOTHORAX, ASSOCIATED WITH PNEUMOMEDIASTINUM, ATELECTASIS, PULMONARY EDEMA, AND SUBCUTANEOUS EMPHYSEMA, OCCURRING DURING LABOR: MEDIASTINAL AIR BLOCK*

By NATHAN JAMES FURST, M.D., and LEWIS R. LAWRENCE, M.D.

NEWARK, NEW JERSEY

WE DESIRE to present a case of bilateral pneumothorax, associated with pneumomediastinum, atelectasis, pulmonary edema, and subcutaneous emphysema, occurring in a parturient woman immediately following delivery. The actual roentgenographic visualization of this combination of acute pulmonary accidents is of sufficient rarity to warrant mention. It is believed that the various clinical and roentgenological findings in this instance are the result, not of a fortuitously synchronous occurrence of unrelated thoracic episodes, but of a clearly definable pattern of pathological events. This concept was originally introduced by Macklin and Macklin,⁹ leading investigators of the mechanism of the appearance of atmospheric air in the interstices of the connective tissues of the lungs, pleurae, mediastinum, pericardium, and subcutaneous and retroperitoneal structures. Although the term "interstitial emphysema" is defined as the presence of air or gas in the connective tissues, the use of the phrase will be restricted, in this paper, to the occurrence of atmospheric air in the tissues mentioned.

It is felt that a review of the accumulated experimental and clinical contributions to this subject will enhance the interest which this case presents.

HISTORICAL AND EXPERIMENTAL BACKGROUND OF INTERSTITIAL EMPHYSEMA

The physiopathology of emphysema of the interstitial tissues has received the

attention of clinicians since the first known recorded description of air in the soft tissues of the face, neck and chest observed in a parturient in 1783.⁵ Since then, the literature is replete with reports of cases of emphysema of varying degrees of severity and occasioned by a host of causes. These reported cases are usually catalogued under the diverse headings of interstitial emphysema due to:

- I. Extrinsic factors
 - (1) Surgery of head, neck, chest or abdomen
 - (2) Trauma to head, neck, chest or abdomen
- II. Intrinsic factors
 - (1) Known origin
 - (a) Inflammatory or malignant diseases of the head, neck, chest or abdomen, such as influenza, malignancies of the intestinal or urinary tracts with perforation, etc.
 - (b) Respiratory efforts of an unusual or violent degree occurring during illness (pertussis), the performance of physiological functions (defecation), parturition, strenuous work or sports.
 - (c) Bronchial obstruction due to endogenous factors (mucus plug or proliferative lesion) or exogenous agents (toys, food, instruments).
 - (2) Undetermined origin

Spontaneous mediastinal emphysema, a syndrome introduced by Hamman⁷ in 1934, and at present reported with increasing frequency.

The syndrome of benign spontaneous pneumothorax has frequently been reported in the past as an entity separate and distinct from spontaneous mediastinal

* From the Department of Radiology, Newark Beth Israel Hospital, Newark, New Jersey. Dr. Nathan James Furst, Director; Lewis R. Lawrence, Resident.

emphysema. It is largely due to the experimental investigations of Macklin and Macklin that a unitary physiological mechanism underlying the various non-traumatic and non-surgical manifestations of atmospheric air appearing in the interstitial tissues of the lungs, mediastinum and subcutaneous tissues was conceived. According to these investigators, the basic physiologic alteration occurs in the pulmonary alveoli and, more specifically, in those alveoli whose bases abut upon bronchi, bronchioles and blood vessels in the connective tissue septa. If such alveoli are overexpanded or hyperinflated as a result of increased respiratory effort, and if the blood vessels in the supporting tissue septa cannot expand *pari passu* with the hyperinflated alveoli, a pressure gradient is created between the alveoli and the pulmonary vessel sheath. When the pressure gradient achieves a level great enough, rupture of the alveoli takes place with resulting entrance of minute air bubbles into the perivascular sheaths. With continued leakage of air, there is coalescence of the small air bubbles, as they are progressively propelled toward the hilum, where they may form actual blebs of appreciable size. Eventually, rupture of these blebs into the mediastinum may occur.

THE SYMPTOM COMPLEX OF MEDIASTINAL AIR BLOCK

Small amounts of air in the mediastinum may produce little or no discomfort. The presence of increasing quantities of air in the mediastinum, however, cannot long be tolerated, for there is compression of the pulmonary vessels and great vessels of the heart and mediastinum. In addition to this potentially grave threat to the mediastinal circulation, there is interference with the respiratory movements of the lungs caused by splinting action of the air in the interstitial pulmonary tissues. These two obstructive factors, the one circulatory, the other respiratory, combine to produce a symptom complex, which Macklin and Macklin have entitled "air block," and

which may prove to be progressive and irreversible.

Fortunately, there are several methods or mechanisms by which this pressure may be reduced or relieved. The air in the mediastinum may dissect a pathway upward along the fascial planes toward the root of the neck, face and axillae, or downward into the retroperitoneal spaces. Again, the air from the mediastinum may rupture into the pleural cavity via a tear in the mediastinal septum, giving rise to a pneumothorax, or into the pericardium, causing a pneumopericardium.

ALVEOLAR RUPTURE AS A CAUSE OF "SPONTANEOUS PNEUMOTHORAX" AND "SPONTANEOUS PNEUMOMEDIASTINUM"

In his experiments, C. C. Macklin observed the presence of air bubbles penetrating the connective tissue of the lung from the perivascular sheaths and burrowing their way to the subpleural surface with the formation of blebs. Rupture of these blebs produced pneumothorax. More commonly, however, Macklin found that pneumothorax was due to air, accumulated under pressure in the mediastinum, erupting through the mediastinal septum into the pleural cavity. Hamman and Macklin and Macklin are agreed that the rupture of air into the pleural cavity from the mediastinum is a more logical and, experimentally, a more plausible explanation for the development of the syndrome of benign spontaneous pneumothorax than the classical theory of the rupture of a pre-existing subpleural emphysematous bleb, idiopathic or congenital.

As regards those cases of pneumomediastinum which appear to have arisen spontaneously, the Macklins believe that the *modus operandi* is exactly the same as in those cases in which an exciting cause is apparent or known, i.e., alveolar rupture with propulsion of coalescing air bubbles toward the mediastinum, and rupture of the mediastinal septum with production of a pneumomediastinum. In these cases of

spontaneous mediastinal emphysema, the Macklins mention the possibility of a depression of thoracic muscle tone with resulting small areas of atelectasis, which provoke a compensatory alveolar ectasia of the surrounding lung tissue. The stage is thus set for alveolar rupture. The occurrence of lesser degrees of bronchial obstruction, clinically unrecognized, but sufficient to cause alveolar overdistention, is likewise suggested. Hamman was of the opinion that alveolar walls may be stretched and remain overinflated as a result of these exciting factors, and rupture hours after the original initiating cause.

In reviewing the 39 cases of spontaneous interstitial emphysema of the mediastinum collected by Fagin and Schwab,³ the following information relative to antecedent contributory factors is elicited. In 6 cases, a definite appreciable effort was revealed: playing golf, lifting a patient, dribbling a basketball, playing a trombone, playing volley ball, and vomiting due to alcoholism. In 4 cases, the syndrome appeared after a walk, in 2 during light manual labor, and in 6 cases, during the course of a respiratory infection. One patient developed emphysema while receiving fever therapy, 1 while in diabetic ketosis, 1 after coughing, 2 after driving and, in 16 cases, no contributory factor was discovered.

In another series of 7 cases reported by Schwartz, McIlroy and Warren,¹⁶ the symptoms appeared immediately after playing tennis in 1 instance, after a long hike in another, after running in a third, during a walk in 2 cases, and 1 episode occurred while the patient was at rest.

Obviously, only a few individuals subjected to physical or respiratory efforts of an unusual degree subsequently present the syndrome of interstitial emphysema. Hamman and the Macklins think that there may exist a defect of the tissue quality of the alveolar structure facilitating alveolar rupture in certain individuals. It would be logical to expect the recurrence of episodes of interstitial emphysema in such cases. One of Hamman's cases de-

veloped episodes of spontaneous pneumothorax on five different occasions, subsequent to an authenticated instance of pneumomediastinum. Pinckney's case, cited by Fagin and Schwab, had three separate attacks of pneumomediastinum, as well as three episodes of spontaneous pneumothorax. In the case reported by Dassen and Fongi, likewise cited by Fagin and Schwab, the patient had five attacks of pneumomediastinum within a few weeks and a recurrence the following year. In one of the original cases presented by Fagin and Schwab, the patient gave a history of two prior episodes of the syndrome. In Case 6 reported by Schwartz, McIlroy and Warren, the patient, who was found to have a left pneumothorax as well as a pneumomediastinum on his first and only hospital admission, gave a history of similar attacks of chest pain and discomfort approximately five times a month for one year. These episodes were precipitated by running or physical training. A similar tendency toward recurrence is noted in one of the cases mentioned by Vanderlaan and Maresh,¹⁸ as well as in the case presented by Schendstock.¹⁵

Finally, Dickie² recently published a study of 20 students who were found to have spontaneous pneumothorax, or spontaneous mediastinal emphysema, or a co-existence of the two conditions. Six students proved to have spontaneous pneumothorax without demonstrable mediastinal emphysema, 7 students gave evidence of pneumomediastinum without demonstrable pneumothorax, and 7 students presented a combination of the two conditions. It should be noted, however, that this investigator was able to demonstrate the presence of mediastinal air by roentgenoscopy or roentgenography in only 3 of the 14 cases in which a diagnosis of mediastinal emphysema was made. The diagnosis was otherwise established clinically by the presence of Hamman's sign, a crunching or crackling bruit, synchronous with the heart sound, but not associ-

ated with respiration, and best heard along the left lateral border of the sternum. In a further analysis of the 7 cases presenting both pneumomediastinum and pneumothorax, Dickie noted a verified recurrence of the mediastinal emphysema associated with pneumothorax, as well as a prior episode of contralateral pneumothorax, unaccompanied by pneumomediastinum, in 1 case. Two more patients had verified prior episodes of uncomplicated pneumothorax, and in 2 other patients, the history was strongly suggestive of prior episodes of pneumothorax and/or pneumomediastinum. In a footnote, the author mentions 7 additional cases of spontaneous pneumothorax, 6 of which were associated with mediastinal emphysema.

In recapitulation, a tabulation of the 63 cases of spontaneous pneumomediastinum reported by the authors cited above (but not including the cases described in Dickie's footnote), indicates that the roentgen examination of the thorax revealed no evidence of pneumomediastinum or pneumothorax in 19 cases, evidence of pneumothorax but no pneumomediastinum in 22 cases, evidence of pneumomediastinum but no pneumothorax in 11 cases, and evidence of both pneumothorax and pneumomediastinum in 11 cases. The presence of pneumothorax in clinically established cases of pneumomediastinum was thus roentgenologically demonstrated in approximately one-third of the cases. In 15 per cent of the cases studied, a definite tendency to recurrence of the syndrome was observed, with an occasional patient exhibiting alternating episodes of pneumomediastinum and/or pneumothorax. Lastly, those episodes which were precipitated by a known effort (running, physical training) differed in no way, obviously, from those which appeared without demonstrable cause.

It is therefore logical to assume that the syndromes of benign spontaneous pneumothorax and spontaneous pneumomediastinum result from identical physiopathological mechanisms and that there is no basis for dissociating one or the other as

a separate and distinct entity. Further, any distinction between those cases precipitated by a known cause and those arising apparently spontaneously is an arbitrary one. The need for thorough roentgen examination of the thorax in these cases must be stressed.

ATELECTASIS AS A CAUSE OF ALVEOLAR ECTASIA

It was stated above that Macklin postulated the importance of atelectasis as a causative factor in producing a compensatory alveolar ectasia. Adcock¹ subsequently reported a case of a patient who developed interstitial emphysema of the lungs, mediastinum, retroperitoneal and subcutaneous tissues while receiving fever therapy. Roentgen examination revealed a small patch of atelectasis in the left lower lung field. No evidence of pneumothorax was noted, however. In 1944, Miller¹¹ described the case of a soldier who developed marked respiratory distress twelve hours after a tonsillectomy performed under local anesthesia. Roentgenogram of the chest showed a massive atelectasis of the right lung. Subsequent studies disclosed the presence of mediastinal and subcutaneous emphysema. In this case, again, there was no demonstrable evidence of pneumothorax. In 1945, Lavenstein⁸ submitted the record of a two year old female, Negro, who was admitted for ingestion and probable aspiration of kerosene. Two days after admission, the patient suddenly became dyspneic, and upon physical examination, crepitation of the anterior chest wall was noted. Roentgen study of the chest revealed an increase in density in the right lower lobe, ascribable to consolidation or to atelectasis. Roentgenoscopic examination later in the day showed evidence of bilateral pneumothorax, mediastinal emphysema, and pneumopericardium. Further studies of the thorax confirmed the presence of bilateral pneumothorax and mediastinal emphysema. No evidence of pneumopericardium was discovered subsequent to the roentgenoscopy, however.

Lavenstein postulated the existence of a diffuse pneumonitis following the aspiration of the kerosene, and the development of focal areas of atelectasis, surrounded by zones of compensatory emphysema, with consequent alveolar distention and ultimate rupture, resulting in the introduction of air along the vascular sheaths. Rogers¹⁴ in 1946 described a case of bilateral pulmonary infarction and bilateral pneumothorax which may be explained on a similar basis.

INTERSTITIAL EMPHYSEMA OCCURRING DURING LABOR

The occurrence of interstitial emphysema during labor, though a frequently mentioned complication, is nevertheless rare. In 1907, Kosmak, quoted by Gordon,⁵ reported a total of 77 cases in the literature. Gordon surveyed the literature in 1927 and his total of 130 collected cases included 2 of his own. Nussbaum¹² reported a case in 1937 and mentioned the occurrence of 12 additional cases since Gordon's series, but his references were not detailed. In 1938, Pendred,¹³ at the occasion of a medical meeting, spoke of 1 case in his experience, and he was followed by Phillips,¹³ who stated that he had observed this dramatic complication of labor 5 times in his experience. Finally, McGuire and Bean¹⁰, Greene,⁶ Faust,⁴ and Stanley¹⁷ each reported a single case. Thus, in all, 135 cases have been reported and reference made in the literature to 13 additional cases since the original recorded description by Simmons⁵ appeared in 1783.

In almost every instance where details were made available, the patient was a young robust primipara, whose labor had been unusually long and difficult. In an analysis of all the cases reported since the publication by Gordon, it was determined that 33 parturients developed the syndrome of interstitial emphysema well before the actual delivery (and hence prior to the possible administration of a general anesthetic agent, reference to which is missing in most instances), 20 patients developed

the syndrome after delivery, and in 3 instances, the emphysema appeared at the very moment of delivery.

Roentgen examination of the thorax in these 33 cases was reported in only 11 instances. In 3, the examination was negative, and in the remainder, there was only evidence of subcutaneous emphysema. Two fatalities are recorded in the entire series. According to Gordon, 1 case was autopsied and disclosed rupture of the pulmonary alveoli beneath the pleura, but there was no evidence of emphysema of the interstitial pulmonary tissues.

CASE REPORT

The patient, M. H., a white, twenty-four year old, robust primipara, at term, was admitted June 15, 1946, at about 2:00 A.M. Her labor pains at the time of admission were described as infrequent and of short duration. Her past history as well as her obstetrical record was not noteworthy. Her last menses had occurred September 13, 1945. Urinalysis was consistently negative; blood pressure varied from 120/80 to 130/86, and pulse rate was well within normal limits. She had gained 28 pounds during pregnancy and at the time of entry into the hospital, she weighed 178 pounds.

Some short time after admission, the patient's pains became more frequent, stronger and more effective. At 7:00 A.M., an estimated five and a half hours after the onset of labor, the patient was taken into the delivery room and prepared for delivery. A general anesthesia of nitrous oxide, oxygen and ether was begun at 7:15 A.M., episiotomy performed and low outlet forceps applied. Delivery of a normal female child was effected at 7:25 A.M., and the placenta was expressed at 7:35 A.M. The condition of the patient during labor was noted as "good" on the labor room record chart, and no untoward episode was observed by the anesthetist. At 7:45 A.M., the patient reacted and promptly began to complain of shortness of breath. This difficulty increased rapidly within the next twenty minutes, during which time the patient complained of a severe pain in the right anterior chest. The pain subsequently spread to the left chest. By 8:15 A.M., the patient was markedly dyspneic and orthopneic. The administration of oxygen by nasal catheter was then begun. The pulse at this time was 168,

respirations 40 and blood pressure 170/90. Adrenalin, minims-vi, and morphine sulphate, gr. $\frac{1}{4}$, were administered hypodermically.

At 9:00 A.M., the patient was examined by a medical consultant. Examination at this time revealed a markedly dyspneic, cyanotic and restless patient, whose respirations were gasping and shallow. There was puffiness of the face and neck, and distention of the neck veins. Auscultation of the chest disclosed loud coarse rhonchi

streaks of radiolucency paralleling the upper aspects of both borders of the heart were visualized. Similar though more clearly apparent streaks were outlined coursing through the superior mediastinal area into the deep soft tissues of the cervical region, bilaterally. There was little displacement of the heart and mediastinum, and the position of the diaphragmatic leaflets was not remarkable. The following impressions were recorded: bilateral, diffusely dis-

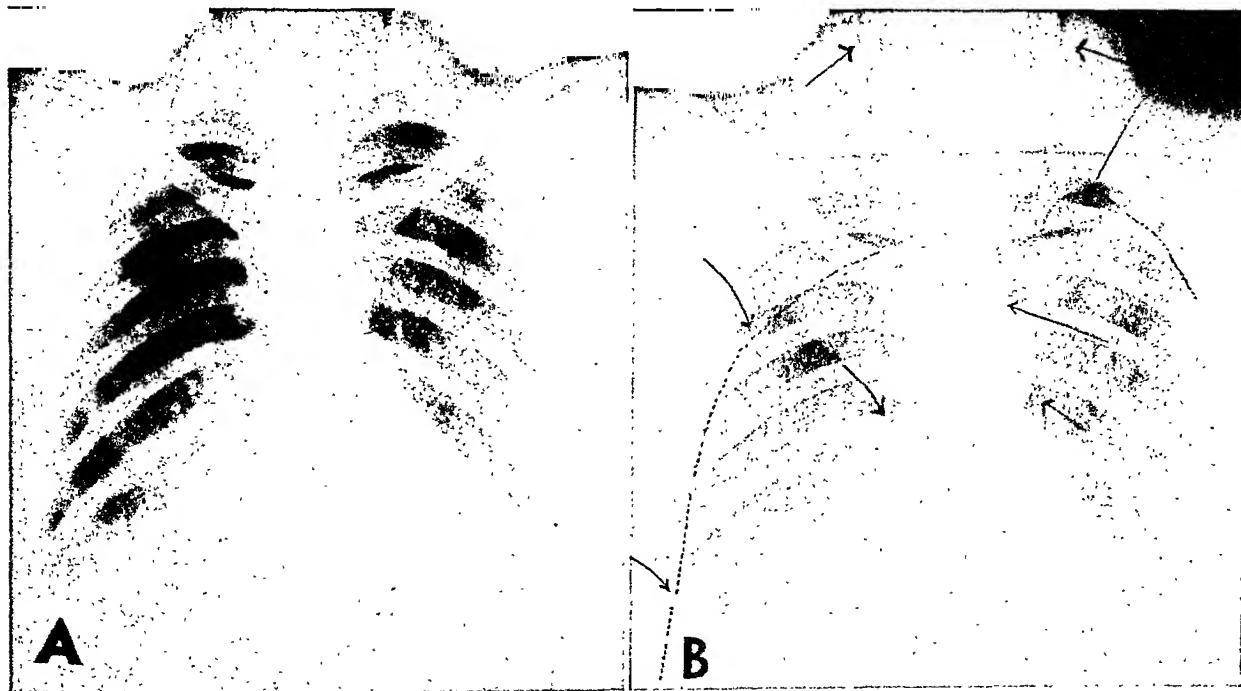


FIG. 1. (A) Portable roentgenogram of the chest shows the disseminated punctate densities in both lung fields, with confluence of the lesions in the right cardiophrenic angle. The subcutaneous emphysema is well visualized, but the pneumomediastinum and the bilateral pneumothoraces are difficult to reproduce (see B). (B) To facilitate orientation, dotted lines have been used to denote the location of the collapsed portions of each lung. The lower arrows point to the pneumomediastinum, the upper arrows to the cervical soft tissue emphysema.

and wheezes throughout both lung fields. A diagnosis of pulmonary infarction was made and 2 cc. of papaverine was given intravenously.

At 10:00 A.M., a roentgenogram of the patient's chest was taken with a portable unit. This examination (Fig. 1) showed the presence of innumerable small rounded areas of density throughout both lungs. There was coalescence of these areas of density into larger, less well defined patches in the right cardiophrenic angle. A 25 per cent collapse of the right upper lobe and a smaller degree of collapse of the right middle and lower lung fields were noted. A small apical pneumothorax was also observed on the left side. Discrete but definite linear

seminated punctate areas of density, compatible with widespread focal atelectasis, aspiration pneumonitis, or pulmonary edema; atelectasis, right lower lobe; bilateral pneumothorax; pneumomediastinum; and subcutaneous emphysema.

During the next forty-eight hours, the patient's course continued stormy. Her pulse and respirations, as well as her blood pressure, remained elevated. There was no rise in temperature. A typical Hamman's sign was elicited on the second day, and crepitation was noted on palpation of the chest wall and the soft tissues of the neck. Treatment consisted of continuous administration of oxygen by nasal catheter and small doses of codeine. A second portable roent-

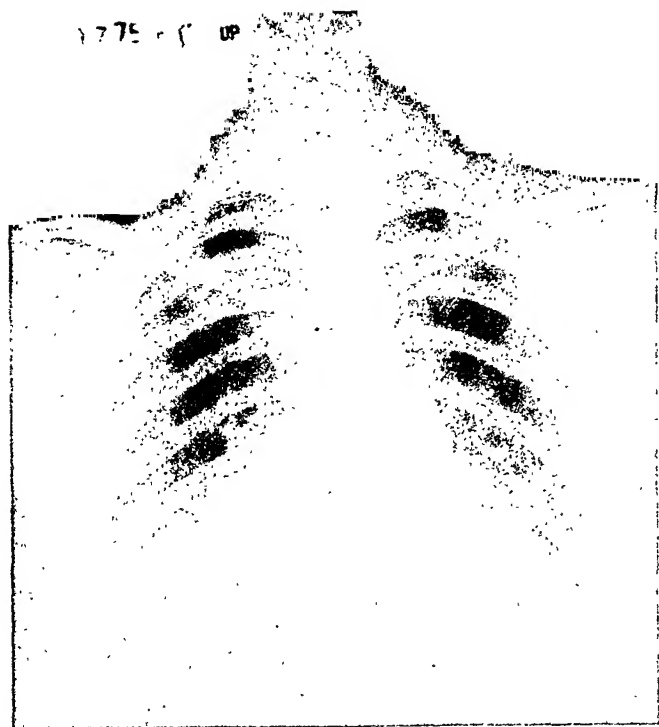


FIG. 2. Portable roentgenogram of the chest taken forty-eight hours after Figure 1. There is massive atelectasis of the right lower lobe, with displacement of the trachea and mediastinal structures to the right. The diaphragm is elevated on the right side. There is marked clearing of the previously noted bilateral, diffusely disseminated densities noted in the first examination. Residual subcutaneous emphysema is present. The residual collapse of the right lung is not demonstrated.

genogram of the chest (Fig. 2) was taken forty-eight hours after the initial study. There was noted at this time a massive collapse of the right lower lobe, with displacement of the trachea and mediastinal structures to the right, as well as slight elevation of the right leaflet of the diaphragm. There was persistence of only a small degree of the pneumothorax previously noted in the right chest, whereas the left apical collapse was no longer evident. Lastly, there was marked resolution of the diffusely scattered areas of density observed on the initial roentgenogram.

The patient improved gradually thereafter. On the tenth hospital day, the patient was permitted out of bed for short periods of time. A third roentgen study of the chest, again made at the patient's bedside (Fig. 3), showed the lung fields to be of normal aeration. The heart appeared slightly enlarged, and examination in the central department was suggested. A general physical examination, including blood pressure, pulse and temperature, as well as auscultation of the thorax, was reported within nor-

mal limits, and on the thirteenth hospital day the patient was discharged without further studies. Several months later, it was learned that the patient was again pregnant.

COMMENT

On the basis of this patient's expulsive efforts, the administered anesthesia, and the eventual clinical and roentgenological findings, the following train of events may be postulated. As the result of the increased respiratory effort incident to active labor, and the inevitable straining with closed glottis, there ensued alveolar distention. Another factor of importance in provoking alveolar distention in this case was the existence of endobronchial obstruction, probably in the form of a mucus plug, resulting in atelectasis, the presence of which is strikingly apparent in the second roentgenogram (Fig. 2). As a consequence of the compensatory alveolar dilatation, there occurred the now familiar pattern of alveolar rupture, and escape of air into the

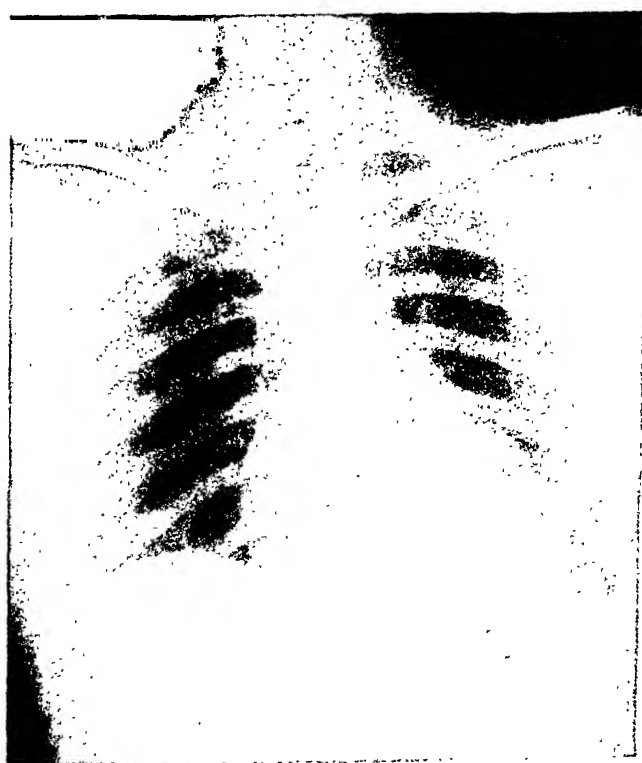


FIG. 3. Portable roentgenogram of the chest taken on the tenth hospital day. There is still residual subcutaneous emphysema noted in the left cervical region. The lung fields appear normally aerated. The heart appears slightly enlarged.

perivascular sheaths, with subsequent eruption into the mediastinum and the deep cervical soft tissues, and finally into the right pleural cavity, as was evidenced by the severe pain in the right chest. With continued leakage of air into the right pleural cavity, mounting tension developed and ultimately, there was entry of air into the left pleural cavity from a second rent in the mediastinal septum. This second pneumothorax was heralded by the spread of pain to the patient's left chest. At this moment, the patient, whose condition was then frankly alarming, presented the malignant symptom complex of "mediastinal air block."

It is of interest, at this point, to review, in retrospect, the first roentgenogram (Fig. 1). It appears very unlikely that the widespread mottled densities represent areas of aspiration pneumonitis, especially in view of the persistent lack of febrile reaction and the evanescent character of the lesions. The two other possibilities considered were focal atelectasis and pulmonary edema. The existence of massive atelectasis of the right lower lobe is not disputed (Fig. 2). However, it is less likely that the disseminated areas of opacity throughout both lungs are attributable to smaller, focal zones of atelectasis. This hypothesis could be based only upon the existence of innumerable endobronchial obstructions. Again, the lack of febrile reaction or other sequelae militate against this possibility. It would appear more reasonable to entertain the likelihood of the presence of pulmonary edema, especially in view of the symmetry and extent of involvement.

The dreaded possibility of the development of pulmonary edema as a terminal complication of "mediastinal air block" has been emphasized by Macklin and Macklin. It is felt that in the case presented there was rapid development of mediastinal embarrassment and unrelieved stasis in the pulmonary circulation with resultant edema of the lungs. The process fortunately proved to be reversible.

SUMMARY

1. The historical, experimental and clinical background of the syndrome of interstitial emphysema has been reviewed.
2. The literature of interstitial emphysema occurring in the parturient has been brought to date.
3. A very unusual case of "mediastinal air block" occurring in a parturient and affording graphic clinical and roentgenological corroboration of the conclusions empirically determined by Hamman and Macklin and Macklin has been presented.

Lewis R. Lawrence, M.D.
830 Prospect Place
Brooklyn 16, N. Y.

REFERENCES

1. ADCOCK, J. D. Spontaneous interstitial emphysema of the lung, with mediastinal, retroperitoneal and subcutaneous emphysema. *Arch. Int. Med.*, 1943, 71, 650-657.
 2. DICKIE, H. A. Spontaneous mediastinal emphysema and spontaneous pneumothorax—with report of 20 cases. *Ann. Int. Med.*, 1948, 28, 618-629.
 3. FAGIN, I. D., and SCHWAB, E. H. Spontaneous mediastinal emphysema. *Ann. Int. Med.*, 1946, 24, 1052-1072.
 4. FAUST, R. C. Subcutaneous emphysema during labor. *Northwest Med.*, 1940, 39, 24-26.
 5. GORDON, C. A. Respiratory emphysema in labor, with 2 new cases and review of 130 cases in the literature. *Am. J. Obst. & Gynec.*, 1927, 14, 633-646.
 6. GREENE, J. A. Unusual sounds emanating from the chest; cause and diagnostic significance of bubbling, clicking, crunching, knocking and tapping sounds, with report of 2 cases of interstitial emphysema of lung and mediastinum. *Arch. Int. Med.*, 1943, 71, 410-414.
 7. HAMMAN, L. Mediastinal emphysema. *J.A.M.A.*, 1945, 128, 1-6.
 8. LAVENSTEIN, A. F. Ingestion of kerosene complicated by pneumonia, pneumothorax, pneumopericardium, and subcutaneous emphysema. *J. Pediat.*, 1945, 26, 295-400.
 9. MACKLIN, C. C. Pneumothorax with massive collapse from experimental local over-inflation of the lung substance. *Canad. M. A. J.*, 1937, 36, 414-420.
- MACKLIN, C. C. Transport of air along the sheaths of pulmonic blood vessels from alveoli to mediastinum; clinical implications. *Arch. Int. Med.*, 1939, 64, 913-916.
- MACKLIN, M. T., and MACKLIN, C. C. Malignant

- interstitial emphysema of the lungs and mediastinum as an important occult complication in many respiratory diseases and other conditions; interpretation of the clinical literature in the light of laboratory experiment. *Medicine*, 1944, 23, 281-358.
10. MCGUIRE, J., and BEAN, W. B. Spontaneous interstitial emphysema of the lungs. *Am. J. M. Sc.*, 1939, 197, 502-509.
11. MILLER, H. Spontaneous mediastinal emphysema. *Ann. Int. Med.*, 1944, 21, 998-1010.
12. NUSSBAUM, F. H. Subcutaneous emphysema arising during labour. *Brit. M. J.*, 1937, 2, 1169.
13. PENDRED, V. Minutes of Obstetrical Society meeting. *Brit. M. J.*, 1938, 1, 54.
PHILLIPS, P. *Ibid.*
14. ROGERS, H. M. Bilateral pulmonary infarction and pneumothorax complicating hypertensive, coronary heart disease with myocardial infarction. *Am. Heart J.*, 1946, 32, 519-528.
15. SCHENDSTOCK, J. D. Recurrent spontaneous emphysema of mediastinum with concomitant pneumothorax. *New England J. Med.*, 1946, 235, 511-513.
16. SCHWARTZ, B. M., McILROY, G. H., and WARREN, H. A. Acute mediastinal emphysema. *Ann. Int. Med.*, 1946, 25, 663-676.
17. STANLEY, R. Interstitial emphysema during labour. *Brit. M. J.*, 1943, 1, 477.
18. VANDERLAAN, W. P., and MARESH, G. Significance of mediastinal emphysema; report of 2 cases. *New England J. Med.*, 1946, 235, 617-619.



A STUDY OF THE EFFECT OF CERTAIN DRUGS ON CURLING OF THE ESOPHAGUS*

A PRELIMINARY REPORT

By A. SHEINMEL, M.D., C. A. PRIVITERI, M.D., and M. H. POPPEL, M.D.

NEW YORK, NEW YORK

IT IS the purpose of this paper to present a preliminary report of the effects of certain drugs on esophageal curling.

Although we have encountered 15 cases in the past eighteen months our pharmacological study was restricted to the 2 cases exhibiting severe or moderate pain.

The roentgenological incidence of curling has up to now been considered uncommon. The subject is practically unknown outside the field of roentgenology. Radiological textbooks (Templeton, Golden) mention the subject, indicating that most cases are asymptomatic. Textbooks on the gastrointestinal tract, general medicine and surgery omit mention of curling entirely.

Curling is a roentgen term describing multiple, irregular, alternating, localized contractions and dilatations of the esophagus created by incoordinated multiple segmental muscle spasms which, as pointed out by Palugyay, do not necessarily encircle the esophagus but may be located anteriorly, laterally or even posteriorly. They usually extend from the level of the aortic arch down to the level of the diaphragm and are believed by some authorities to be of myogenic origin (Golden's tertiary contractions). Most often the condition occurs in males past middle age, but occasionally it may occur during the second or third decades (Templeton). Most often curling is asymptomatic, but in 2 of our cases it produced severe to moderate pain.

During roentgenoscopy, the spasms will be seen to develop best when the esophagus is full. The contractions are more pronounced in the horizontal position. They are stationary and do not progress downward or upward. They may be evanescent

or quite persistent and are independent of each other as regards extent and phase. A peristaltic wave may partially or completely eradicate the curling.

The subject has been complicated by the use of many synonyms, some of which are misleading. For example: reflex spasm (Rössle in 1912), spastic pseudodiverticula (Palugyay in 1931), segmental spasm (Bársony in 1926), pseudodiverticulosis, functional diverticula of the esophagus (Penner in 1942). All these terms presume a knowledge of the pathologic physiology. This, however, is unknown to date. In 1933 Schatzki suggested the term "Kräuselung" or curling. We favor retention of this designation until the pathogenesis is determined.

Templeton suggested that curling may be primary, unassociated with other abnormalities; or secondary to other pathological conditions. Bársony, Rössle and Teschendorf believe it to be secondary to gastrointestinal or other intra-abdominal pathological conditions creating reflex spasms in the esophagus. Penner found curling associated with laryngeal and central nervous system pathological conditions. Imbalance of the neuromuscular mechanism was suggested by Carlson. Our cases of curling were found with and without other pathological conditions.

During the past eighteen months we have studied both clinically and roentgenographically 11 cases and observed roentgenographically 4 additional cases. They were found either accidentally during preliminary observation of the esophagus prior to gastrointestinal study or in esophagrams performed for unexplained symp-

* From the Department of Radiology of the U. S. Veterans Administration Hospital, Bronx, New York, Dr. Charles Gottlieb, Senior Consultant. Thanks are due to the Medical Illustration Division for the illustrations.

toms. Our experience leads us to believe that the condition is not common. Undoubtedly many more cases could be found by diligent and routine esophageal studies.

Our findings support the belief of most authors that curling is due to segmental muscle spasms. Under direct roentgenoscopic observation we noted in some of the cases varying sized segments of the esophagus go into sudden spasm. The intervening portions were relaxed. The lumen may be completely or partially obliterated,

An interval of four to seven days was allowed between the administration of the various drugs. The effects of benzedrine and amyl nitrite have never before been reported in the literature. Our findings are summarized in Table I.

Briefly, atropine and belladonna may reduce the extent of the curling in some cases and abolish it in others. This differs with Teschendorf and Penner who reported complete disappearance of the curling. Amyl nitrite inhalation completely

TABLE I

PHARMACOLOGIC FINDINGS IN CURLING OF THE ESOPHAGUS

Case No.	Degree of Curling	Esophageal Pain	Associated Disease	Age Yr.	Effect of Drugs			
					Amyl Nitrite	Benzedrine	Atropine	Belladonna
I	Severe	Severe	Biliary calculus and duodenal ulcer	50	Abolished temporarily	Abolished lasting effect	Decreased	Decreased
II	Moderate	Moderate	None	52	Abolished temporarily	Abolished lasting effect	Abolished lasting effect	Abolished lasting effect

creating temporary stasis in the esophagus. In other cases the curling is more or less persistent.

The fact that in 2 of our cases the severity of the pain paralleled the degree of curling prompted us to study the effects of various antispasmodics to ascertain whether or not the pain and the curling could be eliminated. In both cases other etiological factors were carefully excluded. Accordingly then, 2 cases with moderate to severe pain were selected for pharmacologic studies under roentgenoscopic and film control after:

1. Hypodermic administration of atropine sulfate gr. 1/100 every four hours for two to four doses;
2. Oral administration of tr. belladonna, 15 minims, three times a day for periods of four to fourteen days;
3. Oral administration of benzedrine sulfate, 5 mg. every four hours for thirty-six hours, and
4. Inhalation of amyl nitrite pearls.

eliminates the curling but it recurs as soon as the effects of the drug wear off. Benzedrine also completely abolishes the curling but its effect is more lasting than from amyl nitrite inhalation.

REPORT OF CASES

CASE I. C. I., white male, aged fifty, had severe esophageal pain, during meals, of fifteen years' duration, unrelieved by medications. Severe curling was demonstrated with the occurrence of esophageal pain during the segmental spasms. Amyl nitrite inhalations abolished the curling and the pain. The same effects were obtained with benzedrine. Atropine and belladonna, however, were less effective from the standpoint of elimination of pain and curling (Fig. 1 and 2).

CASE II. S. F., white male, aged fifty-two, complained of moderate esophageal pain, for many years, occurring during swallowing of food, unrelieved by medications. Roentgen studies demonstrated curling concomitant with pain. Response to amyl nitrite and benzedrine

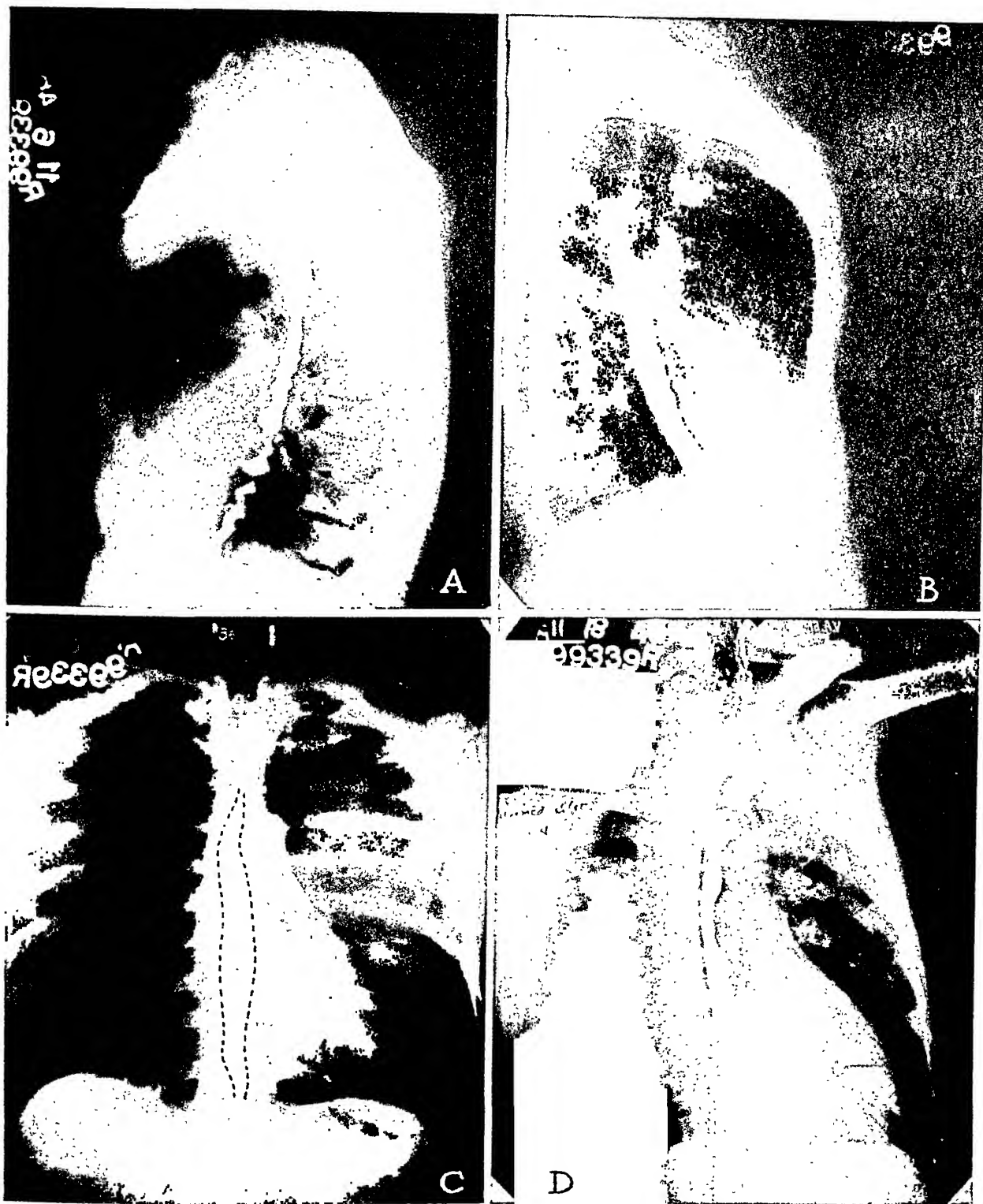


FIG. 1. Case I. (A) Severe curling associated with severe pain—status just before giving amyl nitrite. (B) and (C) Total but transient relief of curling and pain during inhalation of amyl nitrite. (D) Return of curling immediately after amyl nitrite inhalation.

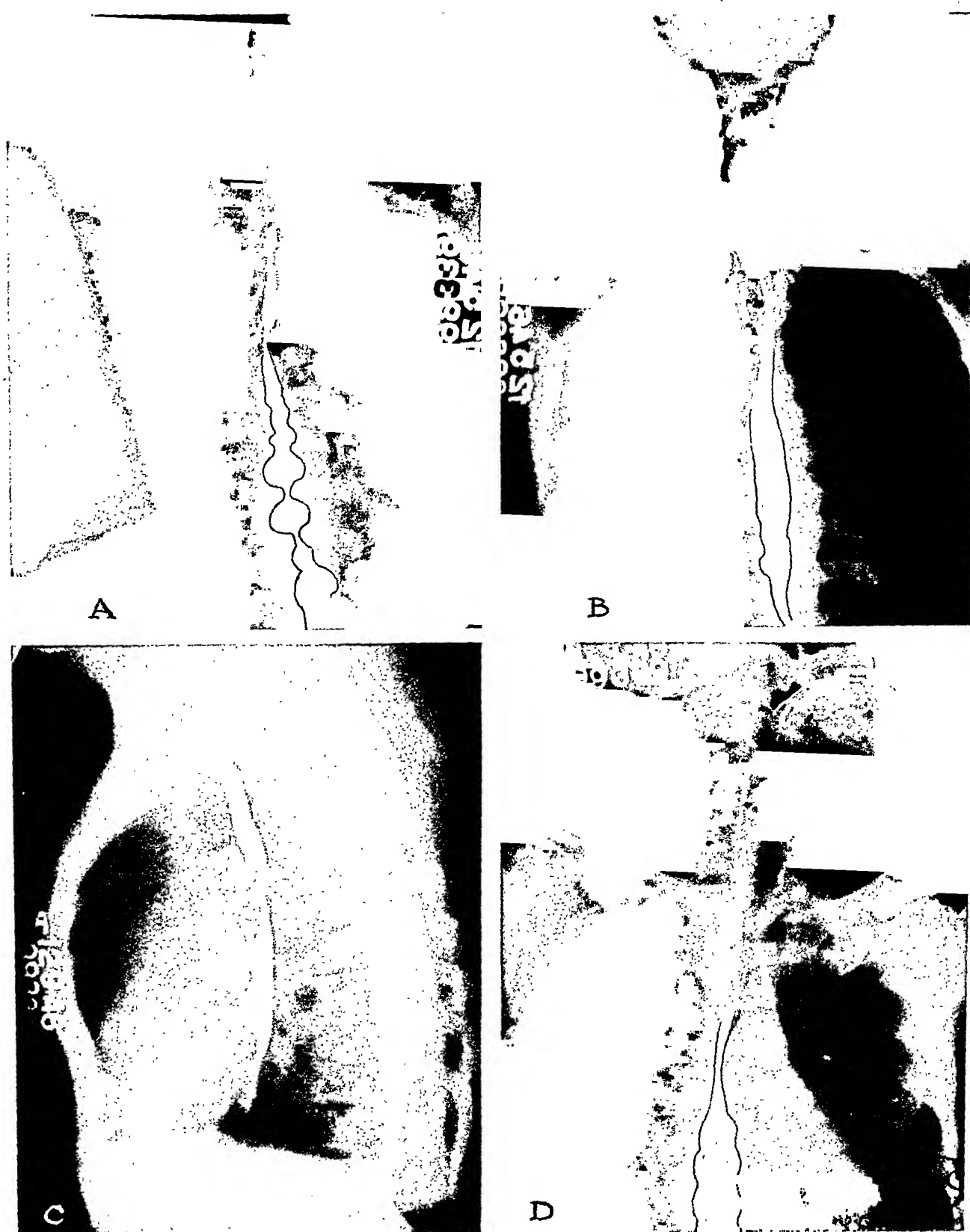


FIG. 2. Case 1. (A) Curling a few days before administration of benzedrine. (B) Total and lasting relief of curling and pain—after benzedrine 5 mg. *q*h for thirty-six hours. (C) Incomplete relief of curling and pain after belladonna min. 15 t.i.d. for four days. (D) Incomplete relief of curling and pain after atropine gr. 1/100 (hypo) *q*h during previous twenty-four hours.

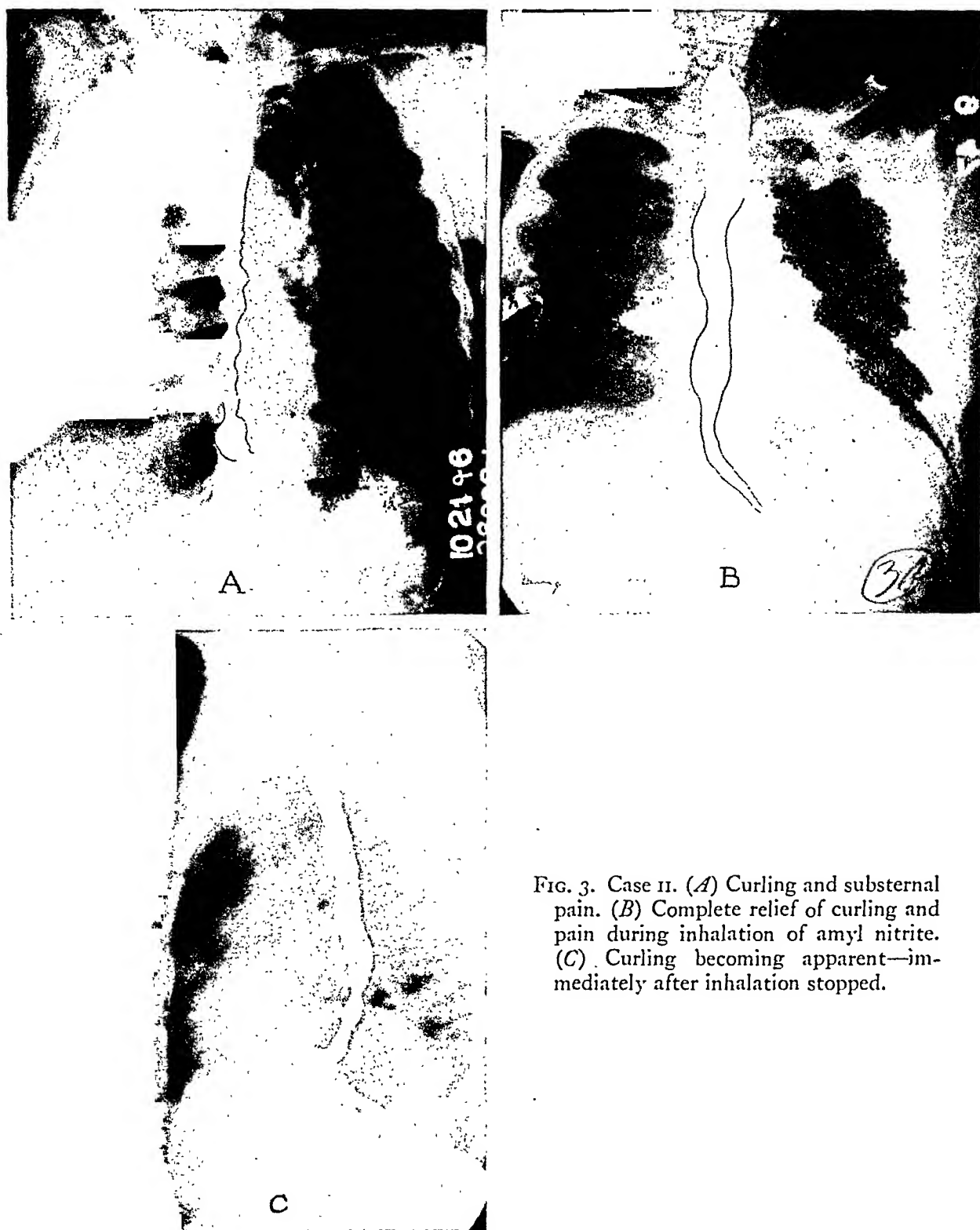


FIG. 3. Case II. (A) Curling and substernal pain. (B) Complete relief of curling and pain during inhalation of amyl nitrite. (C) Curling becoming apparent—immediately after inhalation stopped.

was identical with Case I. However, the patient responded just as well to atropine and belladonna with complete disappearance of curling and the pain (Fig. 3 and 4).

CONCLUSIONS

1. Curling of the esophagus is uncommon, but not rare.
2. Curling of the esophagus is believed to be produced by incoordinated unrelated segmental spasms of the smooth muscle.
3. Curling is usually asymptomatic but may produce esophageal pain.
4. Curling and its symptoms are relieved completely but temporarily by the inhalation of amyl nitrite, completely and

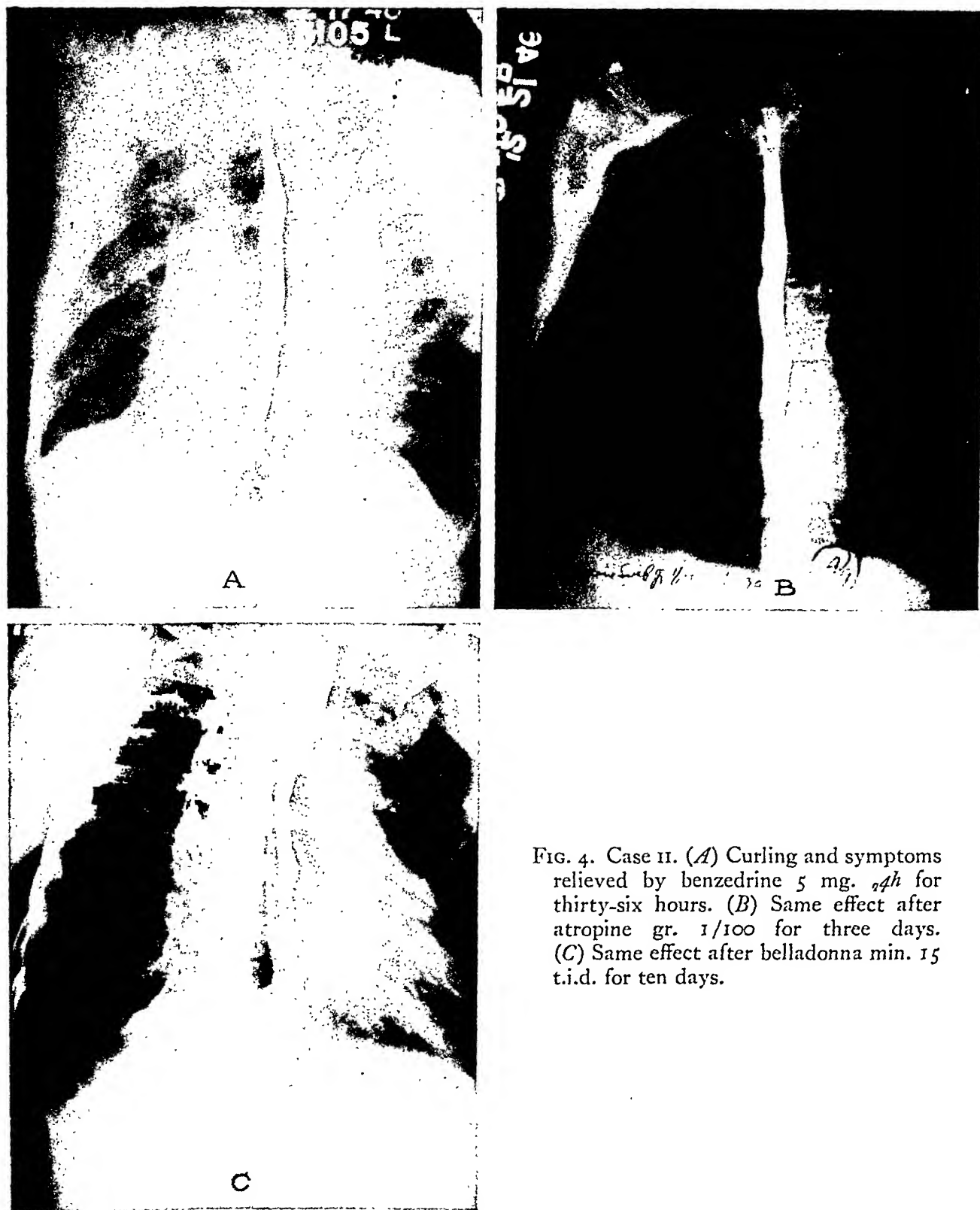


FIG. 4. Case II. (A) Curling and symptoms relieved by benzedrine 5 mg. *q4h* for thirty-six hours. (B) Same effect after atropine gr. 1/100 for three days. (C) Same effect after belladonna min. 15 t.i.d. for ten days.

of longer duration by benzedrine, and less completely by atropine and belladonna.

5. Curling in parkinsonism is coincidental.

M. H. Poppel, M.D.
114 East 54th St
New York 22, N. Y.

REFERENCES

1. BARCLAY, A. E. Normal mechanism of swallowing. *Brit. J. Radiol.*, 1930, 3, 534-546. The practical importance of mechanics in digestion. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 40, 325-334.
2. BARCLAY, A. E. *The Digestive Tract: A Radiological Study of its Anatomy, Physiology, and*

- Pathology. Cambridge University Press, 1933.
3. BARD, PHILIP, Editor. Macleod's Physiology in Modern Medicine. Ninth edition. C. V. Mosby Co., St. Louis, 1941, pp. 920-927.
 4. BÁRSONY, T. Funktionelle Speiseröhren-Divertikel (Relaxations-Divertikel). *Wien. klin. Wchnschr.*, 1926, 39, 1363-1364.
 5. BÁRSONY, T., and POLGÁR, F. Symptomlose und funktionelle Speiseröhrendivertikel. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1927, 36, 593-602.
 6. CARLSON, A. J. Local spasms of esophagus. *J.A.M.A.*, 1922, 78, 786.
 7. GRIER, G. W. Spasm in the middle of the esophagus. *Radiology*, 1924, 2, 265-266.
 8. GOLDEN, ROSS, Editor. Diagnostic Roentgenology. Thos. Nelson & Sons, New York, 1947, p. 272.
 9. KAHN, R. H. Studien über den Schluckreflex. II. Die motorische Innervation der Speiseröhre. *Arch. f. Physiol.*, 1906, 114, 335.
 10. MOSO, A. Ueber die Bewegung der Speiseröhre. *Untersuch. z. Naturl. d. Mensch. u. d. Thiere*, 1876, 11, 327.
 11. MOSHER, H. P. Involvement of esophagus in acute and in chronic infection. *Arch. Otolaryng.*, 1933, 18, 563-598.
 2. PALUGYAY, J. Röntgenuntersuchung und Strahlenbehandlung der Speiseröhre. J. Springer, Wien, 1931.
 13. PALUGYAY, J., and PEŠEK, G. Gestörter Ablauf der Ösophagusperistaltik mit Pseudodivertikelbildungen. *Röntgenpraxis*, 1934, 6, 417-420.
 14. PENNER, A., and DRUCKERMAN, L. J. Segmental spasms of the esophagus and their relation to parkinsonism. *Am. J. Digest. Dis.*, 1942, 9, 282-287.
 15. RÖSSLE, R. Das runde Geschwür des Magens und Zwölffingerdarmes als zweite Krankheit. *Mit. a. d. Grenzgeb. d. Med. u. Chir.* 1912, 25, 766.
 16. SCHATZKI, R. Reliefstudien an der normalen und krankhaft veränderten Speiseröhre. *Acta radiol.*, supp. 18, 1933, pp. 1-149.
 17. TEMPLETON, F. E. X-Ray Examination of Stomach. University of Chicago Press, Chicago, 1944.
 18. TEMPLETON, F. E., and MOORE, P. M. Cardiospasm and normal esophagus; roentgenologic study of muscular action. *J.A.M.A.*, 1944, 124, 733-734.
 19. TESCHENDORF, W. Die Röntgenuntersuchung des Speiseröhre. *Ergebn. d. med. Strahlenforsch.*, 1928, 3, 175-288.



EMPHYSEMATOUS CHOLECYSTITIS*

By JACK FRIEDMAN, M.D., J. RICHARDS AURELIUS, M.D., and LEO G. RIGLER, M.D.

University of Minnesota

MINNEAPOLIS, MINNESOTA

THE roentgen demonstration of gas in the gallbladder and biliary ducts is not an uncommon occurrence at the present time. Gas may gain entrance to the gallbladder and to the biliary tree in one of three manners:

1. The most common source of gas in the gallbladder and biliary ducts is by way of a fistulous communication between the gallbladder or common bile ducts into the duodenum or colon, commonly called the internal biliary fistula.

2. Gas frequently enters the gallbladder from the duodenum through an incompetent sphincter of Oddi or following surgical procedure in which a cholecysto-enterostomy or a choledcho-enterostomy is done.

3. Gas may be found in the gallbladder and biliary ducts caused by an intrinsic infection of the gallbladder with gas-forming microorganisms. This method is the most infrequent cause of filling of the gallbladder with gas and is a rare pathological entity. The diagnosis of this condition can only be made by roentgen examination. The recognition of the process is important as a guide to therapy.

In review of the literature the authors have found that the first authenticated case in which gas was found within the gallbladder in a case of acute cholecystitis was reported by Lobingier¹¹ in 1908. At operation he found the gallbladder filled with gas and pus with the mucosa separated from the wall of the gallbladder containing a single stone. In 1922 Tanner¹⁷ reported another such case and at that time he was unaware of the first report of Lobingier. Kirchmayr⁹ in 1925 reported a case in the German literature. Hegner⁶ reported the first case of this entity in which diagnosis was made prior to surgery by roentgen

examination. In 1932 Simon¹⁴ of Czechoslovakia reported a single case in the French literature. Wybauw¹⁹ of Belgium, in 1936 reported a single case and in 1938 Schmidt rereported Hegner's case and added one of his own in that report. Del Campo and Otero³ reported a case in 1940. In 1942 McCorkle and Fong¹² of California reported 3 interesting cases all diagnosed by roentgen examination. Stevenson¹⁶ in 1944 collected 3 reportable cases all diagnosed by roentgen examination. In 1945 Pierini¹³ reported a case in South America and reviewed the literature at that time. Hutchinson⁷ in 1946 reported a case in England. However, his case was diagnosed at surgery and no roentgen examination was done. In the years 1927 to 1948 two cases of emphysematous cholecystitis were observed at the University of Minnesota Hospitals and two cases were found at the Ancker Hospital in St. Paul during the same interval.

GENERAL DISCUSSION

Through usage, emphysematous cholecystitis and emphysematous pericholecystitis have become the terms most commonly accepted in describing this clinical entity. Simon had employed the term pyopneumocholecystitis which may also be an adequate descriptive term for the disease. In 1922 Tanner labeled his case acute gas-producing cholecystitis, which would be similar to that of emphysematous cholecystitis. However, the term, gas gangrene of the gallbladder as used by Pierini and Hutchinson, as will be demonstrated, is a misnomer inasmuch as not all cases of gas in the gallbladder are caused by *Cl. welchii*, and not in all cases of acute cholecystitis in which *Cl. welchii* is found in pure culture is gas also found. Such cases were reported by

* From the Department of Radiology and Physical Therapy of the University of Minnesota and the Department of Roentgenology of the Ancker Hospital, St. Paul, Minnesota, and the University Hospitals, Minneapolis, Minnesota.

Brütt,² Wahlberg,¹⁸ and Koch.¹⁰ Some authors have erroneously included these cases as emphysematous cholecystitis in their reviews.

Clinical data were reviewed in 15 of the 16 reported cases that we have found (the case of Wybauw was not included because the journal describing the case detail was not available to us). The 4 cases reported herewith are included with the 15 other cases from the literature in the analysis of the etiological and clinical data.

Etiology.

Age: The cases have ranged in age from thirty-two to seventy-four years. However, the majority of the cases are in the sixth and seventh decades of life.

Sex: There are 16 males and 3 females reported.

Bacteriology: Of the 19 cases bacteriological reports were found in 13. Of this group of 13 cases culture of the gallbladder contents from surgical specimens was made in 11. This would provide the most accurate method of determination of the microorganism present. In this group *Cl. welchii* was cultured in 7 cases, *E. coli* was found in 2, aerobic and anaerobic streptococci were found in 2 cases, and *Staphylococcus albus* was found in 2. In 2 cases of this group anaerobic cultures were not done.

In 2 of the 13 cases the cultures were made from duodenal contents obtained through a duodenal tube, and *E. coli*, *Cl. welchii* and staphylococci were found in these 2 cases. Very little significance can be given to the findings in the latter group inasmuch as these organisms are the natural inhabitants of the intestinal tract and therefore do not signify the organisms present in the gallbladder itself.

However, there is ample evidence that *Cl. welchii* is the causative organism in the majority of the cases. That the organism was found in pure culture in 7 out of 11 of the cases proved at surgery would support this contention. Gordon-Taylor and Whitby⁵ were able to culture *Cl. welchii* either from the bile contents, from the gallstones, or from the gallbladder wall in

approximately 10 per cent of chronically inflamed gallbladders surgically removed. Andrews and Henry¹ in a study of 91 gallbladders that were surgically removed were able to find *E. coli* present in the wall in 11 per cent of the cases and in the fluid in 16 per cent of cases and were able to culture *Cl. welchii* in the wall in 11 per cent and in the fluid in 9 per cent of the cases.

However, some of the recent authors would indicate that *Cl. welchii* is the main or possibly the only causative organism. This belief is not corroborated by a study of the facts. In 2 operated cases of emphysematous cholecystitis *Cl. welchii* was not found and *E. coli* was present. Sufficient analogous evidence is also available in the frequent occurrence of gas formation in such infections as subphrenic, intrahepatic abscesses and other abdominal abscesses caused by *E. coli*. In cases of diabetes with urinary bladder infections due to *E. coli*, the bladder is filled with gas. Gas is found around the kidney in cases of perinephric abscesses due to *E. coli* in which diabetes is present.

Association with diabetes: It was of interest to note that in the 4 cases herein reported 2 of the cases were known to have moderately severe diabetes for a number of years. Of the total of 19 cases 7 were diabetics and there was no evidence of diabetes in 4 other cases. In 8 cases of the 19 no mention was made in the report of an attempt to determine the presence or absence of diabetes inasmuch as no urinalysis or blood sugar determinations were reported.

Clinical Course. The clinical picture of emphysematous cholecystitis is indistinguishable from those cases of acute cholecystitis which are not characterized by the presence of gas in the gallbladder. The onset of symptoms is acute. Generalized abdominal pain in the epigastric region is present in most cases. The pain is later localized to the right upper quadrant with some radiation to the back and shoulders. Gradual onset of pain was noted in only a few patients. Nausea is present in most cases

and vomiting was noted in 10 of the 19 cases during the acute attack. Jaundice with the acute attack was uncommon but was found in 5 of the 19 cases during previous attacks of biliary colic. A history of previous episodes of gallbladder disease was observed in 13 of the 19 cases. Of this group the majority of the patients had an earlier history of similar symptoms and fatty food intolerance was present to a great degree. A previous history of chronic eructation, fullness and constipation was frequently encountered. No earlier symptoms were noted in 4 cases of the group and in 2 cases no mention was made in the report of any history of previous gallbladder disease.

The temperature varied from 97 to 103° F. However, most cases fell between 99 to 102° F.

Tenderness in the right upper quadrant and rigidity of the muscles and some protective spasm was present in all cases. A palpable mass in the gallbladder region was detected in 10 of the 19 patients.

The white blood cell count varies from 10,950 to 28,200 as maximum quantities. All cases in which a differential count was made exhibited neutrophilia of 80 per cent or more.

Pathology. The gross pathological appearance of the gallbladder, as demonstrated at surgery in most cases revealed a tense, distended gallbladder with thickened walls and discoloration of varying degrees. All cases contained gas within the lumen of the gallbladder with foul smelling exudate of bubbling character. In many cases the mucosa was completely separated from the muscularis and was gangrenous. Biliary calculi were found in the majority of cases. The thickened wall of the gallbladder was crepitant due to the gas within the wall and there were multiple adhesions between the omentum and the adjacent viscera, making the operative procedure even more difficult. The frequent observation of the separation of the mucosa from the muscularis affords an adequate explanation for a portion of the roentgen picture in which the gallblad-

der shadow is delineated by a concentric ring of lesser density representing the layer of gas between the mucosa and the muscularis.

Treatment. Of the 19 cases 12 were treated surgically. Of this group 3 died and 9 recovered. It was the impression of those authors who had seen more than one case, that if the first case was operated upon they would treat the later cases conservatively. The opinion that any form of acute cholecystitis should be treated conservatively is shared by many surgeons. Of the 3 cases that died after surgery 1 case died of a pulmonary embolus four days following surgery. Two cases died on the second post-operative day from a fulminating gas bacillus infection of peritoneum and abdominal wall. Of the 4 cases herein reported only the first case had a cholecystectomy performed. This patient recovered. The other three were treated conservatively and they recovered. Of the total group of 19 cases 7 were treated conservatively, all of whom recovered. Conservative treatment varied from practically no treatment or supportive treatments to the use of sulfonamides, antibiotics, polyvalent gas gangrene serum, and roentgen therapy in 1 case.

ROENTGEN FINDINGS

It is obvious that the clinical differentiation between cases of acute cholecystitis and those cases of acute cholecystitis in which gas has been formed by microorganisms cannot be made. The preoperative differentiation can only be made on roentgen examination. The presence of gas within the lumen of the gallbladder is probably the first stage of the roentgen appearance and this may occur any time after the onset of the initial symptoms (Fig. 2A). McCorkle and Fong have beautifully demonstrated cases in which serial films were made. In 1 case the first film made twenty-four hours after the onset of the symptoms showed no gas in the gallbladder and the next film twelve hours later showed gas filling the lumen of the gallbladder. If films are made in the upright position at this

stage, a fluid level may be demonstrated.

A concentric ring of lesser gaseous density surrounding the gallbladder usually involving the fundus and often extending completely around the viscus appears later (Fig. 1). Gas may still be present within the lumen. Early this shadow is uniformly demarcated. In a later stage the gas is apparently absorbed within the lumen, and the concentric, smooth, well defined ring about the gallbladder becomes streaked and bubble like in nature indicating a mixture of fluid and gas within a limiting membrane (Fig. 1, 3 and 4). The gallbladder is usually distended during the early stages, and later as one watches the absorption of the gas from the lumen the gas becomes more streaked and irregular and slowly decreases; the size of the gallbladder shadow decreases as well. The finding of these bubbles of streaked gas at an irregular distance from the wall of the gallbladder or from the air-filled lumen of the gallbladder would indicate that the pericholecystic tissues are filled with gas as well.

Feldman⁴ states that a fourth diagnostic criterion for the roentgen diagnosis of emphysematous cholecystitis is the absence of gas in the biliary ducts. Del Campo and Otero,³ however, demonstrated that gas was present in the biliary ducts as well as in the gallbladder and we have made the same observation as illustrated in Case III (Fig. 3B). This would indicate that the process had spread into the common duct and into the biliary ducts and a cholangitis is also present.

Many authors believe that in this disease the cystic duct is blocked by a stone. However, many cases have been reported in which no stone was found in the gallbladder and therefore this phenomenon is not necessarily a part of the picture.

We believe that the characteristic picture of streaked, "bubbly" gas within the wall of the gallbladder and in the pericholecystic tissues is pathognomonic for emphysematous cholecystitis. However, those cases in which the lumen of the viscus is filled with gas and in which no gas is pres-

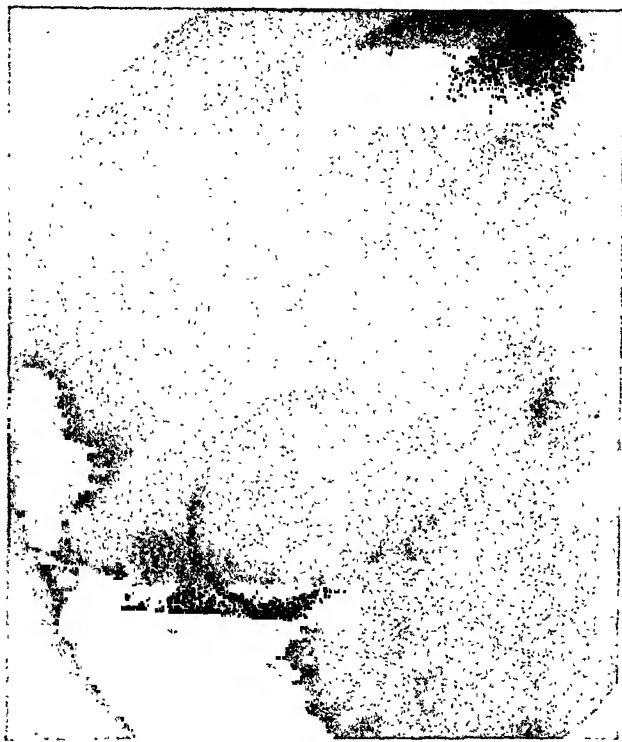


FIG. 1. Case I. Posteroanterior roentgenogram of the gallbladder demonstrating a concentric ring of gas surrounding the gallbladder. Note the streaked and "bubbly" character of the gas shadows. Some bubbles of gas are slightly separated from the concentric ring suggesting gas in the pericholecystic tissues.

ent in the wall must be differentiated from an internal biliary fistula and from gas filling the gallbladder due to incompetence of the sphincter of Oddi. Kerley⁸ has recently demonstrated such a case in which no such fistulous communication could be demonstrated by roentgen examination of the stomach, the duodenum and the colon. However, because of absence of constitutional symptoms in this patient he was reluctant to make a diagnosis of emphysematous cholecystitis, and at surgery a fistula large enough to pass a finger was demonstrated between the gallbladder and the transverse colon.

REPORT OF CASES

CASE I. This patient, a white female, aged fifty-three, was admitted to the University of Minnesota Hospital on December 31, 1928, with complaint of attacks of right upper quadrant pain for five years. Associated with these attacks were vomiting, nausea, belching and

constipation. The pains radiated to the back and to the right shoulder. Following these attacks of pain she occasionally noticed jaundice and dark urine. Her last episode began two days before admission.

On physical examination, tenderness in the right upper quadrant with rigidity of the abdominal muscles on deep palpation was noted. No masses were felt. Temperature on

admission was 99.6°F. Laboratory findings revealed a white blood cell count of 18,350 with 85 per cent polymorphonuclears. The urine was negative for sugar on two occasions.

Roentgen examination revealed the presence of multiple clustered areas of decreased density within the gallbladder and a large area of decreased density surrounding the gallbladder interpreted as accumulation of bubbles of gas

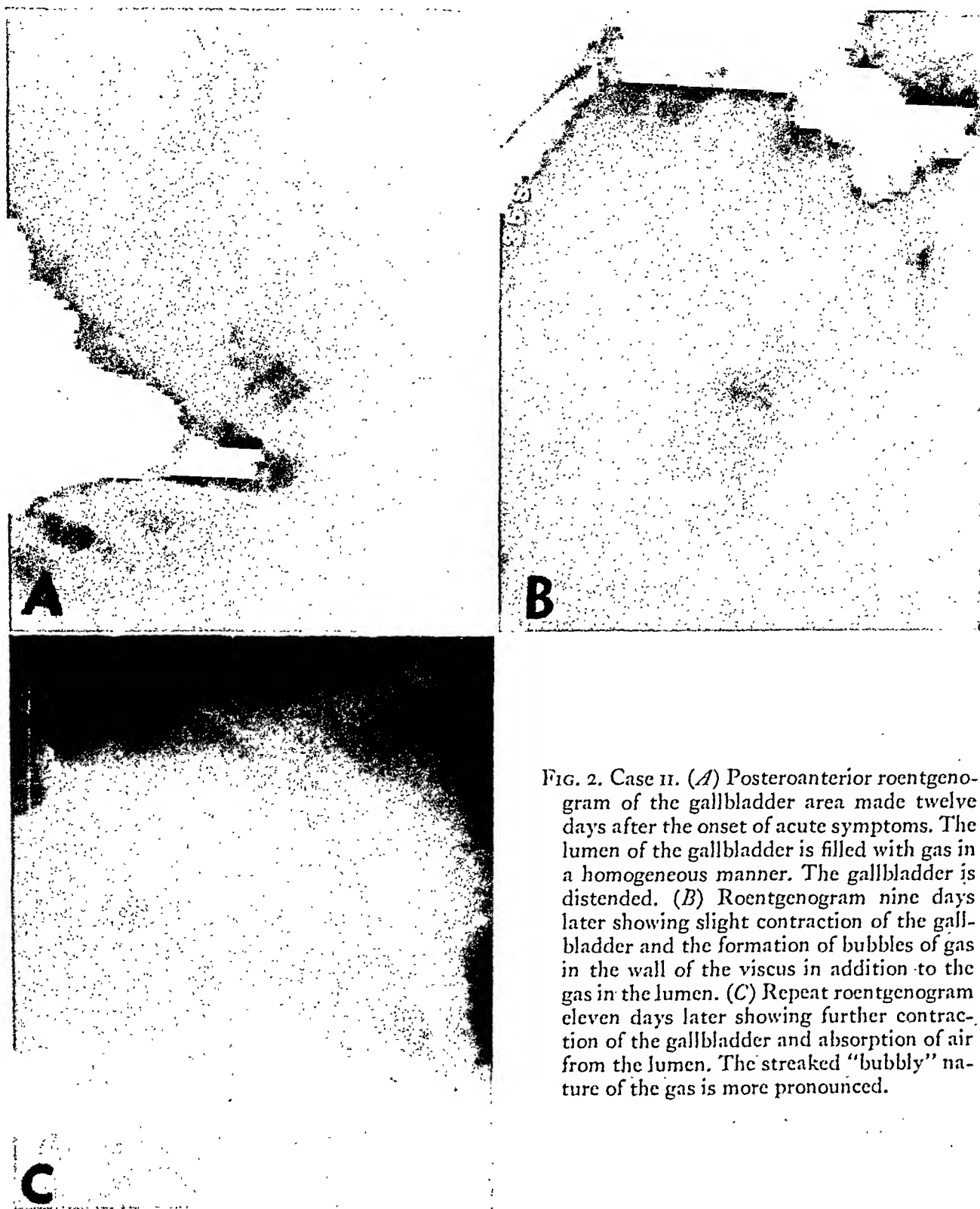


FIG. 2. Case II. (A) Posteroanterior roentgenogram of the gallbladder area made twelve days after the onset of acute symptoms. The lumen of the gallbladder is filled with gas in a homogeneous manner. The gallbladder is distended. (B) Roentgenogram nine days later showing slight contraction of the gallbladder and the formation of bubbles of gas in the wall of the viscus in addition to the gas in the lumen. (C) Repeat roentgenogram eleven days later showing further contraction of the gallbladder and absorption of air from the lumen. The streaked "bubbly" nature of the gas is more pronounced.

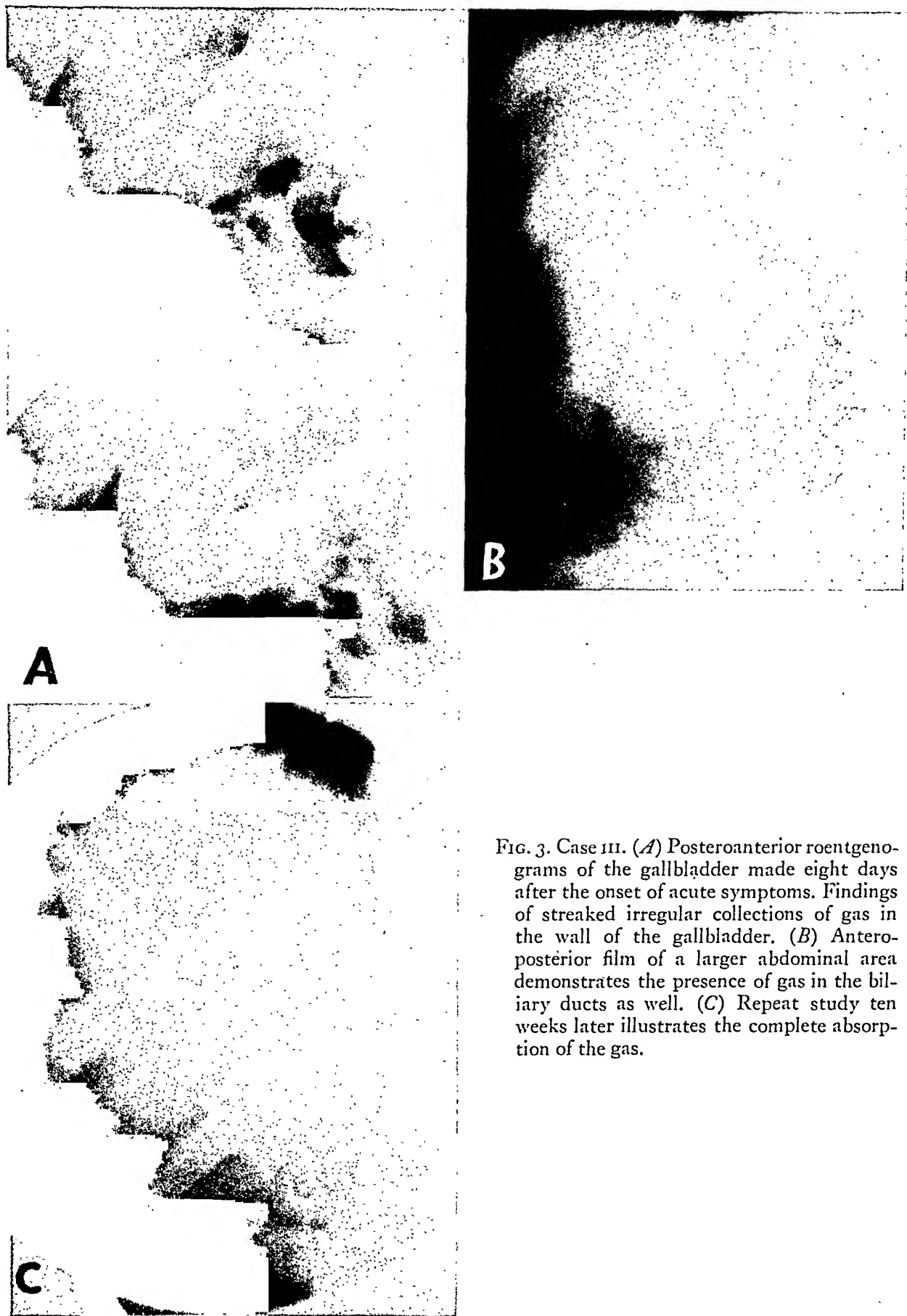


FIG. 3. Case III. (A) Posteroanterior roentgenograms of the gallbladder made eight days after the onset of acute symptoms. Findings of streaked irregular collections of gas in the wall of the gallbladder. (B) Anteroposterior film of a larger abdominal area demonstrates the presence of gas in the biliary ducts as well. (C) Repeat study ten weeks later illustrates the complete absorption of the gas.



FIG. 4. Case IV. Oblique posteroanterior roentgenogram of the gallbladder area exhibits mottled, streaked, bubble-like collections of gas in the wall of the gallbladder.

within the gallbladder wall (Fig. 1). Examination of the stomach, duodenum and colon showed no evidence of fistulous communication between the bowel and biliary tract.

A cholecystectomy was performed on January 10, 1929. The gallbladder was distended, thick walled and surrounded by adherent omentum and colon. The viscus was opened near the fundus and a large quantity of purulent dark colored exudate and gas was evacuated. The mucosa was entirely separated from the muscularis and contained in it a gallstone about 3 by 5 cm. Broth cultures from the gallbladder revealed staphylococci. The agar plates showed no growth. Anaerobic studies were not done.

The patient was discharged from the hospital on February 3, 1929, recovered.

CASE II. This patient, a white male, aged sixty-eight, was admitted to Ancker Hospital on March 1, 1935, with complaint of sudden attack of severe upper abdominal pain with some pressure sensation against the chest. He was nauseated but did not vomit at the onset, but later vomiting occurred and the pain became increasingly severe and localized to the right upper quadrant. This attack appeared eight days before admission to the hospital and has been constant to a great degree but had diminished somewhat in severity since the onset. He had similar attacks of right upper quadrant pain in August and later in October,

1934, but these were not as severe as the attack prior to admission.

Physical examination revealed some tenderness in the right upper quadrant and a small palpable mass was noted below the liver edge on the right. Some abdominal rigidity was also present. Physical examination was otherwise noncontributory.

Laboratory findings showed a white blood cell count of 12,950, with 86 per cent polymorphonuclears on March 8, 1935. The urine examination was essentially negative on two occasions, March 8 and April 8, 1935.

Roentgen examination on March 5, 1935, twelve days after the onset of symptoms, revealed the gallbladder filled with air (Fig. 2A). On March 14, 1935, a repeat examination of the gallbladder area demonstrated the gas to be of more mottled character and "bubbly" in appearance (Fig. 2B). On March 28, 1935, examination of the stomach was negative and the second portion of the duodenum was compressed by the gallbladder. Gas was present in the gallbladder wall on this examination but of more mottled character (Fig. 2C). No fistulous communication was demonstrated between the duodenum and the biliary tract. The patient's symptoms improved spontaneously with no specific therapy. Surgery was not performed and the patient was discharged on April 15, 1935, apparently well.

CASE III. A sixty-six year old male was admitted to the Ancker Hospital on December 22, 1945. The patient was a frequent visitor to the outpatient clinic and had been hospitalized frequently for arthritis, diabetes mellitus, nervousness, cardiac decompensation and pneumonia on previous occasions. Three days before admission he complained of severe pains in the epigastrium spreading to other parts of the abdomen. Vomiting of bile colored emesis occurred at the onset. Maximum pain was substernal and later was located in the right upper quadrant radiating to the back.

The essential physical findings revealed tenderness throughout the abdomen but most marked in the right upper quadrant. Some protective spasm in the right upper quadrant was noted and a mass was palpable in that area below the liver edge. The white blood count on December 22, 1945, was 28,200 with 91 per cent polymorphonuclear leukocytes. This was lower at later dates. The urine was persistently positive for sugar. The patient was a known dia-

betic for many years and had been treated at the Ancker Outpatient Clinic.

Roentgen study of the gallbladder after administration of priodax showed a normal gallbladder on September 18, 1945, but no calculi were noted. This study was done because of symptoms of fatty food intolerance. On December 27, 1945, eight days after the onset of acute symptoms, priodax was again administered and no dye was demonstrated in the gallbladder. However, the gallbladder area was completely surrounded by bubbles of gas and there was possibly some gas within the gallbladder (Fig. 3A). In addition, gas was demonstrated in the biliary ducts on the following day (Fig. 3B). A fistulous communication was not demonstrated between the colon or the duodenum. The gallbladder was examined again on March 16, 1946. There was no concentration of dye within the gallbladder but the gas shadows were no longer visible (Fig. 3C). The patient's acute symptoms had subsided during this interval. Surgery was not performed at that time and the patient refused elective cholecystectomy later.

CASE IV. A white housewife, aged sixty-five, was well until one week before admission to the University Hospital when she suddenly developed right upper quadrant pain and nausea. This was associated with frequent belching and a sensation of gaseous distention in the mid-abdomen. Because of accompanying constipation she took several doses of cascara and epsom salts and this was followed on the fourth day of the illness by a severe diarrhea of frequent foul smelling liquid black stools.

Following several episodes of biliary colic, a cholecystotomy was performed in 1909 with removal of a large gallstone. An appendectomy and partial ovariectomy accompanied this operation. She weighed 95 pounds at this time and within six months she weighed well over 150 pounds and by the end of the year she became enormously obese and at present weighed over 300 pounds. Several children were born to her subsequent to the surgery in 1909. She has been a known diabetic for fourteen years using 65 units of regular insulin daily.

Physical examination revealed an enormously obese patient. Temperature was 99.6°F., pulse 92. There was a firm, rounded, tender mass palpated in the right upper quadrant underlying the scar of the previous operation. This mass appeared to be attached to the scar.

It was thought possibly to be a ventral hernia.

Urinalysis showed 2 plus sugar, 2 plus acetone but no diacetic acid or albumin. The hemoglobin was 11.7, white blood cell count was 10,950, with 80 per cent neutrophils. Examination of the stool for blood with guaiac solution was negative. The fasting blood sugar was 330. The CO₂ combining power was 45 and the blood urea nitrogen 10. Liver function tests were normal, there being no increase in serum bilirubin.

Roentgen examination revealed a concentric semicircular ring of decreased density in the gallbladder area of streaked "bubbly" appearance in both posteroanterior and lateral projections. The findings were interpreted as gas in the gallbladder wall and the diagnosis of emphysematous cholecystitis was made (Fig. 4).

The patient was treated conservatively with a basic diabetic diet containing 1,130 calories and only 50 grams of fat with insulin. A course of streptomycin was given 3 grams daily for three days.

She responded to treatment, became symptom free and was discharged on October 22, 1947.

SUMMARY AND CONCLUSIONS

1. Review of the literature reveals sixteen cases of acute cholecystitis due to gas-forming microorganisms in which gas is present either in the lumen of the gallbladder, in the wall of the gallbladder or pericholecystic tissues or in the biliary ducts.

2. Four new cases of this entity are added to the literature.

3. Analysis of the significant etiological and clinical data are presented in a study of nineteen of the twenty reported cases. These cases are clinically undistinguishable from those cases of acute cholecystitis without the formation of gas.

4. The diagnosis can always be made by roentgen examination.

University Hospital
Minneapolis 14, Minn.

REFERENCES

1. ANDREWS, E., and HENRY, L. D. Bacteriology of normal and diseased gallbladders. *Arch. Int. Med.*, 1935, 56, 1171-1188.
2. BRÜTT, H. Gazbazilleninfektion des Pankreas und

- Pankreasnekrose. *Virchow's Arch. f. Path. Anat.*, 1923, 246, 33.
3. DEL CAMPO, J. C., and OTERO, J. P. Neumatosis espontánea de las vías biliares. *Arch. urug. de med., cir. y especialid.*, 1940, 17, 341-350.
 4. FELDMAN, M. Clinical Roentgenology of the Digestive Tract. Second edition. Williams & Wilkins Co., Baltimore, 1945.
 5. GORDON-TAYLOR, G., and WHITBY, L. E. H. Incidence of anaerobic infections in the gall bladder. *Brit. J. Surg.*, 1932, 19, 619-621.
 6. HEGNER, C. F. Gaseous pericholecystitis with cholecystitis and cholelithiasis. *Arch. Surg.*, 1931, 22, 993-1000.
 7. HUTCHINSON, W. R. S. Gas gangrene of gall bladder. *Brit. M. J.*, 1946, 1, 915-916.
 8. KERLEY, P. A gall-bladder visualised by gas. *Brit. J. Radiol.*, 1940, 13, 289-290.
 9. KIRCHMAYR, L. Ueber einen Fall von Gasbrand der Gallenblase. *Zentralbl. f. Chir.*, 1925, 52, 1522-1527.
 10. KOCH, F. E. Gallenblasen-Gasbrand. *Zentralbl. f. Chir.*, 1933, 60, 2060-2066.
 11. LOBINGIER, A. S. Gangrene of the gall bladder. *Ann. Surg.*, 1908, 48, 72-73.
 12. McCORKLE, H., and FONG, E. E. Clinical significance of gas in the gall bladder. *Surgery*, 1942, 11, 851-868.
 13. PIERINI, A. Gangrene gaseosa de la vesícula biliar. *Día méd.*, 1945, 17, 988-994.
 14. SIMON, J. Le pyopneumocholécyste et son diagnostic radiologique. *Presse méd.*, 1932, 40, 1938-1940.
 15. SCHMIDT, E. A. Emphysematous cholecystitis and pericholecystitis. *Radiology*, 1938, 31, 423-427.
 16. STEVENSON, C. A. Emphysematous cholecystitis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 53-60.
 17. TANNER, E. K. Acute gas producing cholecystitis. *Surg., Gynec. & Obst.*, 1922, 32, 468.
 18. WAHLBERG, K. Die Gasbazilleninfektion des Gallenblase. *München. med. Wchnschr.*, 1927, 74, 2095-2096.
 19. WYBAUW, L. Image vésiculaire inhabituelle. *J. belge gastro-enterol.*, 1936, 4, 123-125.



LIPOMAS OF THE GASTROINTESTINAL TRACT*

By WILLIAM L. PALAZZO, M.D.

TEANECK, NEW JERSEY

LIPOMAS are uncommon tumors of the gastrointestinal tract but are the third most common benign tumor. Adenomatous polyps are the most common such tumors and, in the experience of the Massachusetts General Hospital,⁷ spindle cell tumors are more than three times as common as lipomas. Roentgen determination of the benignity of a tumor is frequently impossible. There are certain characteristics of a lipoma, however, which may aid in its diagnosis.

INCIDENCE

Only 36 cases of lipoma of the gastrointestinal tract have been found in the files and pathologic reports at the Massachusetts General Hospital since 1900. Of this group of 36 lipomas, 22 were found in 12,100 postmortem examinations, or an incidence of 0.182 per cent. This is somewhat higher than that found by Schottenfeld¹³ who notes an incidence of 0.118 per cent, or 46 lipomas in a series of 37,741 autopsies collected from various sources.

TABLE I

AGE INCIDENCE OF PATIENTS WITH LIPOMAS OF GASTROINTESTINAL TRACT

Decade	Number Cases	Lipomas	
		Symptomatic	Asymptomatic*
30-39 yr.	2	2	0
40-49	6	2	4
50-59	9	5	4
60-69	15	4	11
70-79	3	0	3
80-89	1	0	1
Total	36	13	23
Average age	58.2	52.5	61.4

* Incidental finding at surgical operation or at postmortem examination.

* From the Department of Radiology, Massachusetts General Hospital, Boston, Massachusetts.

Of the 36 lipomas, 20 were found in men and 16 in women. The average age of the patient was 58.2 years; the youngest was thirty-seven and the oldest eighty-one years (Table I). None of the lipomas was found in the esophagus; only 6 were in the stomach; 10 were located in the small intestine, and 20 in the colon (Table II). Twenty-

TABLE II

DISTRIBUTION OF LIPOMAS IN GASTROINTESTINAL TRACT

Location	Symptomatic	Asymptomatic	Total
Stomach	0	6	6
Small intestine	2	8	10
Duodenum	0	2	
Jejunum	0	2	
Ileum	2	2	
Ileocecal valve	0	1	
Multiple	0	1	
Colon	11	9	20
Cecum and ascending colon	3	7	
Transverse colon	4	0	
Descending colon and sigmoid	4	1	
Unknown	0	1	
Total	13	23	36

three lipomas were incidental findings, 3 at surgical operation and 20 at postmortem examination. The remaining 13 gave rise to definite symptoms during life, although 2 of them, which were also the cause of death, were not discovered until autopsy.

The average age of the patient in whom the lipoma produced symptoms was 52.5 years. This is nine years younger than that of the group in which the lipoma was discovered incidentally, either at surgery or autopsy. Tenner¹⁶ reported an average age of fifty-three years in a group of 12 patients who had symptoms.

None of the tumors which produced symptoms occurred in the stomach; only 2 were found in the small intestine (both in the ileum), and the remaining 11 were in the colon. Those in the colon were distributed as follows: in the ascending colon 3, in the transverse colon 4, and in the descending colon 4 (see Table II). From Table III it will be noted that the sympto-

TABLE III

SIZE OF LIPOMAS OF GASTROINTESTINAL TRACT

Size	Symptomatic	Asymptomatic	Total
0-1 cm.	0	7	7
1-2	0	8	8
2-3	3	7	10
3-4	1	1	2
4-5	3	0	3
Over 5 cm.	6	0	6
Total	13	23	36

matic lipomas were larger, as a rule, than the asymptomatic.

The nature of the tumors is shown in Table IV. Thirty-three of the entire group were submucous, 21 being sessile and 12 pedunculated; only 3 were subserosal and these gave no symptoms. Of the lipomas producing symptoms, 54 per cent were pedunculated whereas but 25 per cent of the asymptomatic group were pedunculated. This characteristic probably contributed to the production of symptoms. Nine lipomas showing ulceration fell into the symptomatic group; in 2 other patients, no ulceration was found, although a history of blood passed by rectum was obtained. Unlike spindle cell tumors of the intestinal tract, none of this series was malignant.

SYMPTOMATOLOGY

Symptoms had been present for periods ranging from four days to ten years. Of the 13 cases, 7 had had symptoms for less than six months, 5 for more than six months, and in 1 the duration is unknown. In a few instances, vague symptoms had been present for long periods of time, an acute

exacerbation bringing the patient to the attention of the physician. Pain was experienced by 10 patients. This pain was colicky and cramp-like in nature and was usually located in the midline—epigastric, periumbilical, or hypogastric; occasionally, however, it was referred to the lower quadrants. Repeated attacks of mild pain frequently had preceded the final acute exacerbation.

Six patients complained of constipation of long duration. Anorexia, nausea and vomiting were found as a more acute symptom complex, being present from one day to three months in 5 patients. Bleeding by rectum was noted in 3 patients. One, who had had a bloody movement three days before observation, was found to have a double intussusception of the ileum induced by a lipoma; another, who had had two episodes of gross bleeding in one year unassociated with pain, was discovered to have a non-intussuscepting lipoma of the ascending colon. In the third patient who, after experiencing mild recurrent left upper quadrant pain for five years, had several

TABLE IV

NATURE OF LIPOMAS OF GASTROINTESTINAL TRACT

	Symptomatic	Asymptomatic	Total
Submucosal	13	20	33
Sessile	6	15	
Pedunculated	7	5	
Subserosal	0	3	3
Sessile		2	
Pedunculated		1	
Ulcerated	9	0	

“tarry” stools with vomiting for one day, a lipoma of the cecum was proved upon surgical intervention. In the last instance, intermittent intussusception had been observed roentgenographically. Abdominal distention occurred in 3 patients.

In 3 patients, an abdominal mass was felt. In 1, the palpable mass disappeared while the patient was under observation; he was discharged but readmitted one week

later because of recurrence. A lipoma was found in the transverse colon. Although intussusception was not present when this patient was operated upon, it would seem that the recurring mass could best be explained by such a condition. In a second patient, who complained of sharp periumbilical pain, a mass was palpated to the left and below the umbilicus; this was found at operation to be a lipoma in the ascending colon. Intussusception of the mass into the transverse or descending colon would explain its presentation as a mass in the left abdomen. The third patient had a palpable mass in the right upper quadrant, accompanied by abdominal pain, nausea and vomiting; exploratory laparotomy was negative for tumor. The patient died one month later of uremia, and post-mortem examination showed a 3.5 cm. pedunculated lipoma of the ileum.

ROENTGEN DIAGNOSIS

As can be seen, the symptoms of lipoma are usually those of partial or complete obstruction. Often a lipoma cannot be distinguished roentgenologically from other tumors causing intestinal obstruction such as carcinoma, adenomatous polyp, spindle cell tumor, lymphosarcoma, carcinoid, and the like. In 9 cases in which roentgen examination of the colon was performed, tumor



FIG. 1. Lipoma of ascending colon. Note the smooth lobulated filling defect arising from the lateral wall of the colon. This is the typical appearance of an intramural extramucosal tumor.

was recognized in 8; in the remaining case, obstruction at the sigmoid was observed on a plain film of the abdomen.

The roentgen signs of a nonintussuscepting lipoma are those of tumor (Fig. 1, 2 and



FIG. 2. Lipoma of transverse colon. (A) Filling defect, lobulated but smooth. Barium in folds of normal colonic mucosa surrounds the tumor. (B) Lipoma showing ulceration. Mucosal folds proximal to tumor are stretched. Mucosal folds distal to tumor are normal.



FIG. 3. Small asymptomatic lipoma of ascending colon found in course of investigation for diarrhea. This is perfectly smooth and has a broad base.

3). A lipoma, however, unlike carcinoma, seldom or never involves the entire circumference of the wall of the bowel. It may be sessile or pedunculated; if the latter, it may cause a dimpling or a narrowing at its point of origin. The tumor is frequently lobulated but smooth in outline; it may be ulcerated, but this ulceration may not be revealed by roentgen examination. A lipoma may produce the typical signs of an intramural extramucosal tumor as described by Schatzki and Hawes.¹² These signs are those of a smooth filling defect which, when seen in the profile view, shows an abrupt sharp angle at the point where the edge of the tumor meets the uninvolved wall of the bowel. If seen face-on, the lesion is sharply outlined in the relief picture of the bowel. The characteristic features of these lesions are obscured when the bowel

is overdistracted by too much barium. A lipoma showing these features may be indistinguishable from a spindle-cell tumor.

In the presence of a lipoma, one significant finding occurs often enough to warrant special attention. Intussusception was evident in 6, or 45 per cent, of the 13 symptomatic cases. This percentage would rise to 62 if 2 other cases, described above, in which the combination of signs and symptoms strongly suggested intussusception, were included. In Schottenfeld's 275 collected lipomas, intussusception occurred in 36.3 per cent; Lazarus and Marks⁵ report its occurrence in 45 per cent, Stetten¹⁴ in 43 per cent, Dewis¹ in 50 per cent, and Comfort (quoted by Kirshbaum⁴) in 65 per cent.

Five of the 6 cases of intussusception in the present series occurred in the colon and were recognized roentgenographically. The sixth was a compound intussusception of the ileum and in it, the roentgenologic examination revealed a small intestinal obstruction.

Intussusception in the adult is a relatively rare condition. Eliot and Corscaden² state that only 10 per cent of hospital admissions for intussusception occurred in adults. Perrin and Lindsay⁹ found, out of 400 patients, 18 instances of intussusception (5 per cent) occurring after fourteen years of age; in 7 of 8 cases noted in age groups twenty-nine to sixty-one, a tumor was described as causing the intussusception. Iason³ lists the following provocative causes of intussusception in the adult: typhoid ulcers, tuberculous ulcers, dysentery, acute appendicitis, Meckel's diverticulum, a congenital ileal band, a submucous lipoma of the ileum, a foreign body, a sudden radical dietary change, and neoplasm. Tumor, however, is by far the most common cause. Schatzki¹¹ found a tumor to be the causative factor in all of the 11 cases of intussusception of the colon in adults seen during a period of three and a half years at the Massachusetts General Hospital.

Since intussusception so frequently accompanies lipoma, the possibility of its being caused by a lipoma should always be

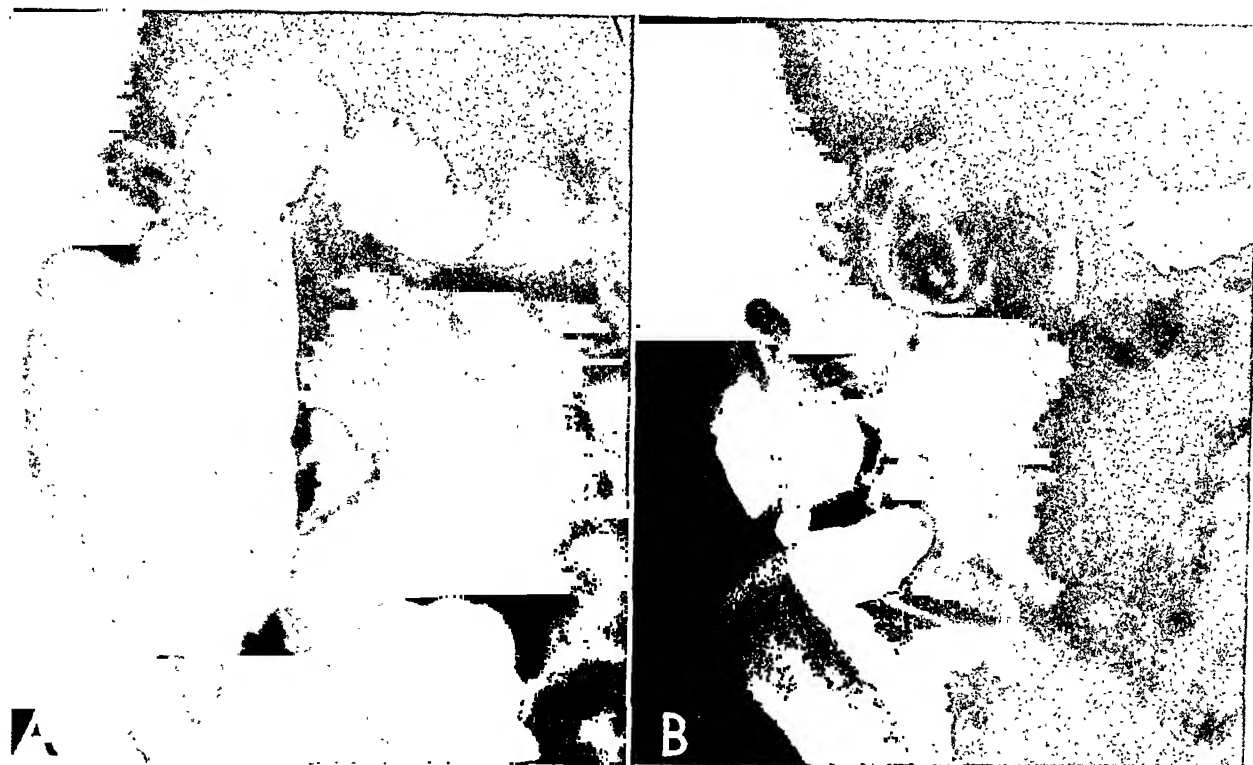


FIG. 4. Lipoma of ascending colon. (A) During filling of colon with barium. (B) Following evacuation. The tumor has intussuscepted into the transverse colon.

considered when intussusception is demonstrated roentgenologically. The signs are classical (Fig. 4, 5 and 6): the tumor usually forms the leading edge of the intussusception (called the intussusceptum, and the bowel receiving the tumor the intussusciens). Barium coating the folds of bowel around the tumor edge gives the characteristic appearance of multiple rings. Sussman¹⁵ has mentioned five diagnostic criteria for intussusception: (1) obstruction to the passage of barium either by meal or by enema, but not often both; (2) a filling defect of variable size at the site of obstruction; (3) a palpable mass at the site of obstruction; (4) a change in position and shape of the filling defect following defecation; and (5) a compression of the adjacent mucosal folds, particularly well seen in the postdefecation films. Schatzki has described various roentgenologic appearances which an intussusception may assume. With an enema, the barium may stop suddenly with the formation of a cap which corresponds to the head of the intussusception. Barium may enter the sheath which



FIG. 5. Lipoma of ascending colon with intussusception. The tumor itself can be seen leading the intussusception. The barium-filled rings in the sheath are well outlined. The right abdomen, normally occupied by the ascending colon, now contains several loops of ileum.

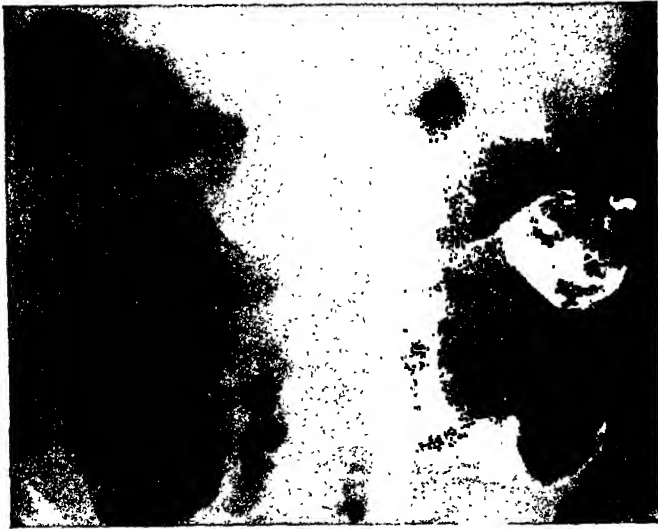


FIG. 6. Lipoma of transverse colon intussuscepted into the descending colon and causing complete obstruction.

surrounds the intussuscepted gut forming two peripheral lines of density. Frequently barium in mucosal folds forms several circular or ring-like lines surrounding the intussusception. Barium occasionally enters the lumen of the intussuscepted bowel. This central canal is usually narrow with longitudinal rugae and is separated from the sheath by a wide, non-filled area which is occupied by two wall thicknesses of intestine and by the intussuscepted mesentery.

Examination following oral administration of barium reveals the same principal changes, except that the proximal intestine is more apt to show dilatation, particularly in cases of ileocecal intussusception. After oral administration of barium, the intussusception is usually more severe, just as it is more marked following evacuation of the barium enema. The tumor causing the intussusception, and usually forming its apex, is more likely to be outlined by barium given by enema than by mouth.

A plain film of the abdomen may be extremely useful in demonstrating an intussusception. The involved intestine is seen as a sausage-shaped, homogeneous shadow, which may be surrounded by the air-filled sheath, represented by two peripheral air stripes or air rings surrounding the "sausage." A suspicious finding is the absence of

the normal feces and air-filled cecum in its usual position in the right lower quadrant, and in its place, gas-filled loops of ileum; this suggests intussusception of either the cecum or ileum into the ascending colon with dilatation of the proximal loops of ileum (Fig. 7).

TREATMENT OF INTESTINAL LIPOMAS

In the treatment of a lipoma of the gastrointestinal tract, as in all types of tumors, the importance of early diagnosis is obvious. The complications of gangrene and peritonitis can be avoided by diagnosis and early surgery. Occasionally a lipoma of the intestine is expelled spontaneously. Lazarus and Marks reported that 11 per cent of the patients in their series thus expelled the lipomas; Ratcliff¹⁰ found 19 per cent. This is an interesting phenomenon, and it should be considered in any obscure case of intestinal obstruction in which the symptoms are relieved spontaneously.

Excision of a pedunculated lipoma or resection of the portion of the intestine containing an intussusception are the only forms of treatment. In none of the cases of this series was there any history of recurrence. The conclusion reached by Oughterson and Cheever⁶ is appropriate: "Every

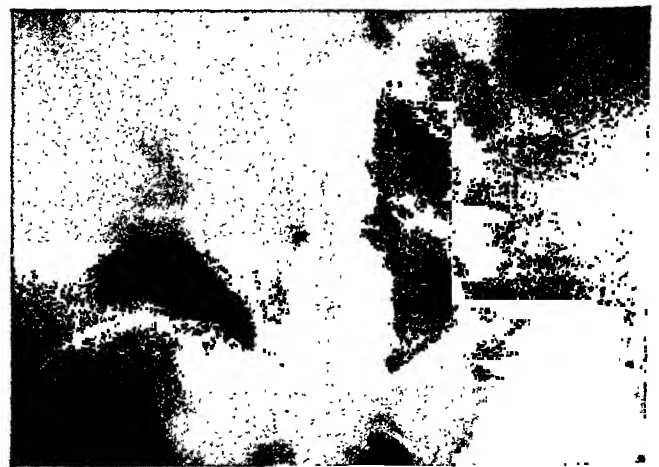


FIG. 7. Lipoma of ascending colon. Plain film of abdomen shows intestinal obstruction, with loops of gas-filled and dilated ileum in the right lower quadrant, and an absence of the normal feces and air-filled cecum. This suggests that the cecum has intussuscepted.

tumor of the gastrointestinal tract, especially if it is situated within the lumen of the intestine, no matter how benign the character of the growth, should be removed unless there is a definite contraindication, since it always carries with it the threat of intussusception." Another, and possibly more important reason for surgical interference is that roentgen diagnosis is still sufficiently inaccurate so that malignancy cannot be excluded.

Two cases in the present series serve to illustrate an important point in the surgical treatment of lipomas. In one case, described above, an exploratory laparotomy failed to reveal a lipoma of the ileum; in the other, roentgenologically diagnosed as a polyp of the hepatic flexure with evidence of intussusception, cholecystectomy was performed. No tumor was felt in the colon, hence it was left intact. Nine months later, because of recurring symptoms, another laparotomy was done; at this time, right colectomy revealed in the resected segment of bowel a lipoma, 9 by 6 cm., attached by means of a stalk to the wall of the colon. The tumor was described as "fluctuant and consisting of soft yellow fatty tissue." Because of this quality of softness, it has been noted repeatedly by surgeons that an intestinal lipoma, being difficult to palpate, may easily be missed even when its presence is known.

SUMMARY

Lipomas are the third most common benign tumors of the gastrointestinal tract; adenomatous polyps and spindle cell tumors are more common.

Thirty-six lipomas, seen at the Massachusetts General Hospital since 1900, have been reviewed in this report. Their distribution was as follows: stomach six, small intestine ten, colon twenty; thirty-three were submucous in position.

Thirteen of the thirty-six lipomas gave rise to symptoms; nine of the thirteen were ulcerated. Six symptomatic lipomas were causative factors in intussusception; two others probably caused intermittent intus-

susception. Symptoms, in the order of frequency, were pain, constipation; anorexia, nausea and vomiting; bleeding by rectum, abdominal distention, and abdominal mass.

The roentgen signs of a lipoma are those of tumor. Unlike carcinoma, lipoma seldom involves the entire circumference of the intestinal wall. It may be sessile or pedunculated; if pedunculated, it may cause dimpling or narrowing at its point of origin. A lipoma is frequently lobulated but is smooth in outline; it may be ulcerated but this may not be recognized roentgenologically. It may produce the characteristic appearance of an intramural extramucosal tumor.

Intussusception is relatively rare in the adult. It occurs, however, in association with approximately 50 per cent of symptomatic lipomas. When it is diagnosed roentgenographically, the possibility of a lipoma as the causative factor should be considered.

Any tumor within the bowel, no matter how benign its appearance, should be removed because of the possibility of intussusception and because, in most instances, it cannot be definitely differentiated from a malignant tumor. At operation, the soft consistency of a lipoma may be misleading, and detailed exploration may be necessary to locate a lipoma that has been roentgenologically demonstrated.

Holy Name Hospital
Teaneck, N. J.

REFERENCES

1. DEWIS. Quoted by Panzer and Porretta.⁸
2. ELIOT, E., JR., and CORSCADEN, J. A. Intussusception with special reference to adults. *Ann. Surg.*, 1911, 53, 169-222.
3. IASON, A. H. Intussusception in adults. *Surgery*, 1945, 7, 457-466.
4. KIRSHBAUM, J. D. Submucous lipomas of intestinal tract, as cause of intestinal obstruction. *Ann. Surg.*, 1935, 101, 734-739.
5. LAZARUS, J. A., and MARKS, M. S. Submucous lipomas of colon with special reference to acute and chronic intussusception. *Am. J. Surg.*, 1945, 70, 114-117.
6. OUGHTERSON, A. W., and CHEEVER, D. Recurring intussusception caused by intestinal neoplasms, requiring multiple operations for

- its relief. *Surg., Gynec. & Obst.*, 1929, 48, 682-686.
7. PALAZZO, W. L., and SCHULZ, M. D. Spindle-cell tumors of gastro-intestinal tract. *Radiology*, 1948, 51, 779-789.
8. PANZER, E. J., and PORRETTA, F. S. Submucous lipoma of transverse colon complicated by intussusception and diverticulosis. *Am. J. Surg.*, 1933, 22, 303-304.
9. PERRIN, W. S., and LINDSAY, E. C. Intussusception. *Brit. J. Surg.*, 1921, 9, 46-71.
10. RATCLIFF, R. A. Submucous lipoma of colon. *Guy's Hosp. Rep.*, 1930, 80, 453-462.
11. SCHATZKI, R. Roentgenologic appearance of intussuscepted tumors of colon, with and without barium examination. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 549-563.
12. SCHATZKI, R., and HAWES, L. E. Roentgenological appearance of extramucosal tumors of esophagus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 1-15.
13. SCHOTTENFELD, L. E. Lipomas of gastrointestinal tract, with special reference to small intestine including ileum; review of literature and report of 6 cases. *Surgery*, 1943, 14, 47-72.
14. STETTEN, D. Submucous lipoma of gastrointestinal tract; report of two successfully resected cases and analysis of literature. *Surg., Gynec. & Obst.*, 1909, 9, 156.
15. SUSSMAN, M. L. Roentgenologic aspect of subacute and chronic intestinal intussusception. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 373-382.
16. TENNER, R. J. Lipomas of large and small intestine; clinical and pathological studies of 12 cases which produced symptoms necessitating surgical intervention. *Journal-Lancet*, 1948, 68, 1-40.



DILATATION OF THE JEJUNUM

By LLOYD E. HAWES, M.D.*

BOSTON, MASSACHUSETTS

AIR-FILLED, dilated small intestine on a plain roentgenogram of the abdomen is a well known sign of intestinal obstruction or of ileus. In addition, segmental dilatation of the small intestine, visible even without contrast media, may indicate the presence of a small intestinal tumor or inflammatory disease. Cases are presented which illustrate dilatation of the jejunum due to tumor, and due to regional enteritis.

Dilatation of a single loop of jejunum or ileum due to intestinal obstruction may last several minutes or hours, but the process is not static. If the obstruction is not relieved, other loops of dilated small intestine begin to appear and the degree of distention increases. With ileus, the entire small intestine is more likely to be air-filled and dilated, rather than a single loop. An isolated dilated loop may be caught in an internal hernial sac, in an incisional hernia, or be the site of a volvulus with multiple adhesions. Again the process is not static. The symptoms increase in severity. The caliber of the incarcerated loop increases. The wall of the dilated intestine is thin and expansile, and is not visible on the roentgenogram.

Dilatation of a single loop of jejunum may indicate tumor. The degree of dilatation is persistent and does not change from day to day. This sign is characteristic of certain non-obstructing tumors including lymphosarcoma, fibrosarcoma, highly undifferentiated carcinoma, etc. The following case is typical in symptoms, roentgen signs, and course.

CASE I. *Lymphosarcoma of Jejunum.*

A female, aged sixty-one, was admitted to the Faulkner Hospital with a history of low grade fever and easy fatigue for one month. There were no localizing symptoms or signs. Numerous laboratory studies were inconclusive; no anemia was present. A chest roentgeno-

gram showed no disease. A month later she was studied elsewhere for the same complaints, and no disease was found. Final admission was five months after the onset of symptoms when she returned with a low fever each afternoon, but reported the new symptoms of intermittent abdominal distention and increased flatus and belching in the last three weeks. A mild anemia was present. Tenderness was present deep in the left lower quadrant. No mass could be palpated.

Roentgen Findings. A plain roentgenogram (Fig. 1) showed a constant, stiff, air-containing loop of jejunum in the left mid abdomen. A barium swallow showed dilatation of the entire

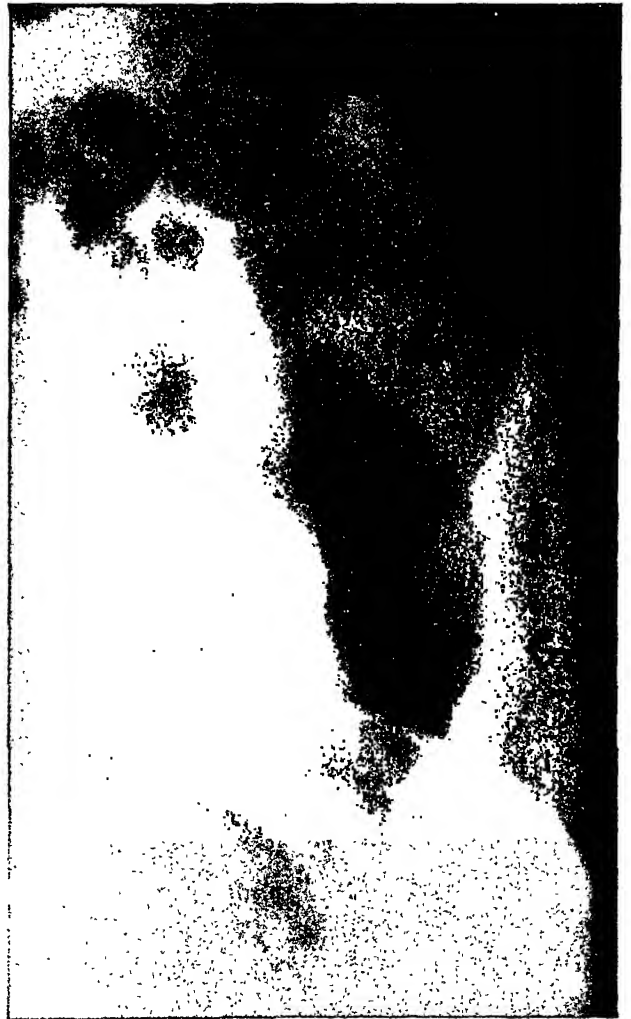


FIG. 1. Case I. Lymphosarcoma of jejunum. Note thickened wall.

* Radiologist, Faulkner Hospital.



FIG. 2. Case 1. Lymphosarcoma of jejunum.

duodenal loop and of the proximal first loop of jejunum (Fig. 2). Arrows distinguish the thickening of the bowel wall. The second loop of jejunum was fixed, rigid, and dilated for a distance of 8 inches. The lumen was considerably widened, and the intraluminal surface was lobulated. The barium filling made the markedly thickened wall more evident (arrows). The small bowel beyond the lesion showed the so-called "deficiency pattern" with increased segmentation, thickened transverse folds, and transient areas of distention.

At operation, an enlarged loop of jejunum with thickened, porky wall was adherent to the anterior parietal peritoneum. Its mesentery was thick, edematous, and stiff. The mesenteric changes were in the shape of a triangle with the apex at the root of the mesentery, close to the spine. A small perforation was present. The entire diseased segment and mesentery were mobilized and removed. The patient died of generalized peritoneal metastases five weeks later.

Gross Pathology. The specimen consisted of a loop of small intestine with attached mesentery. The loop was approximately 30 cm. long. Only about 5 cm. at either end had a fairly normal appearance. The entire central portion

comprising 20 cm. was converted into a greatly thickened, but also dilated, mass measuring 7 cm. in diameter near its central portion where it exhibited perforations or tears on both sides, each about 2 to 3 cm. in diameter. At the site of these tears the wall was quite thin and measured 0.2 to 0.3 cm. Elsewhere it measured up to 1.0 cm. On section it had a white homogeneous, translucent surface. The lining of the distended part was somewhat granular and brownish-gray with only a suggestion of the usual mucosal folds remaining. The mesentery was converted into a dense whitish mass which on section had the appearance of enlarged, fused lymph nodes.

Microscopic Pathology. Malignant lymphoma (stem cell lymphoma differentiating into lymphoblastic lymphoma).

Comment. In a proved case of malignant lymphoma, the following roentgenological changes were observed over a period of three weeks: dilatation of a solitary loop of jejunum, thickening of the wall in the involved loop, rigidity, absence of any normal mucosal markings, broad intraluminal lobulations and altered physiological activity in the uninvolved small intestine. Lingley¹¹ in 1936 published 5 similar cases of "non-obstructing malignant tumors" and recognized many of these diagnostic signs. All had palpable masses, and all were rapidly fatal. Only 2 were resectable. Earlier Wakeley and Paul¹⁶ had recognized the clinical aspects of this type of tumor, but had not distinguished this group.

The high mortality of this type of tumor in contrast to lymphosarcoma, etc., that does not exhibit these signs,^{7,8,14} is probably due to the lack of obstruction. The tumor, when found, is usually of large size, with considerable infiltration of the wall and of the mesentery. The lack of obstruction and failure to become thin and to perforate leads to absence of symptoms for several weeks. A continuous low-grade fever in our case was indicative of the presence of disease for a period of four months before abdominal symptoms helped in localizing the process to the intestine. When a small intestinal tumor presents the above enumerated roentgenological signs, a grave

prognosis even before operation is probably indicated.

Dilatation of a single loop of jejunum may also be due to inflammatory disease and again is static and persistent in contrast to the dilatation of obstruction.

CASE II. Localized Subacute Jejunitis.

A male, aged fifty, was admitted to the Faulkner Hospital after five days of nausea, vomiting, and epigastric pain. The pain became steady and had localized itself to the left of the umbilicus. Ten years previously a gastrointestinal series had been negative.

Examination showed tenderness and spasm to the left of the umbilicus and in the left flank, a temperature of 100°F., and a leukocyte count of 12,700 per cubic millimeter. A clinical diagnosis of diverticulitis was made.

On the fifteenth day of illness, a plain roentgenogram of the abdomen showed a dilated loop of small intestine with air trapped in it. The loop had a thickened wall. The trapped air had a granular appearance. At the distal end of the lesion, two small calcified areas were seen in the soft tissues and were interpreted as calcified mesenteric glands. A barium enema showed considerable spasm of the descending colon lateral to the involved loop and no diverticula.



FIG. 3. Case II. Regional jejunitis. Note dilated proximal small intestine and rigid outline of involved area.

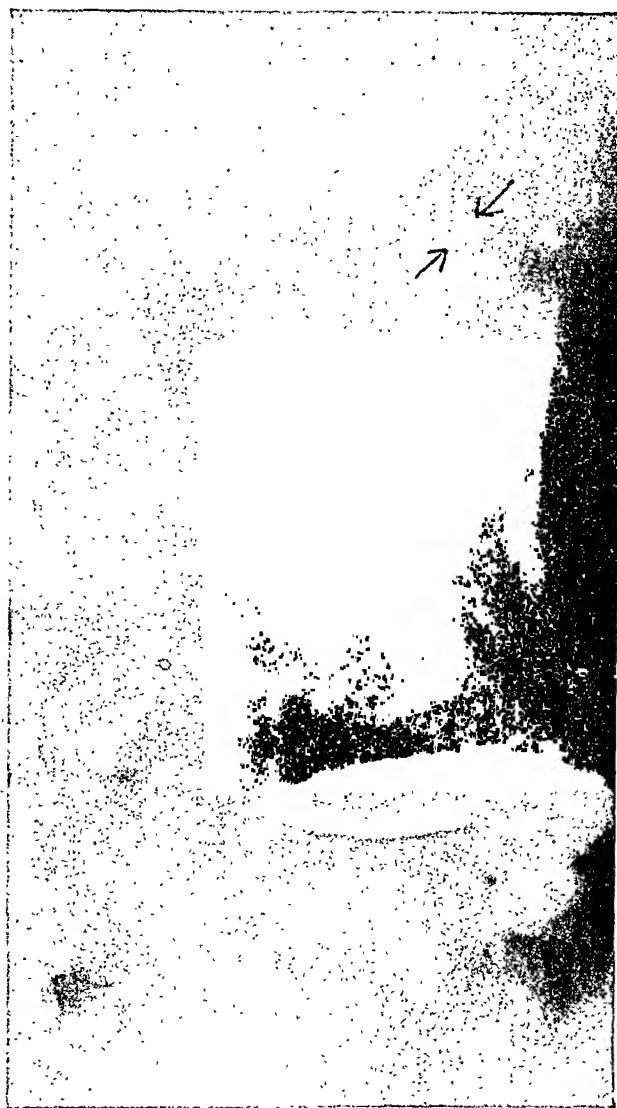


FIG. 4. Case II. Regional jejunitis. Note thickened wall and reticular mucosal pattern.

Gastrointestinal series proved the rigid loop to be very high in the jejunum and only about 10 inches from the ligament of Treitz (Fig 3). The duodenum and jejunum proximal to the lesion were dilated but possessed a normal, though distended, mucosal pattern. Barium rushed by rigid walls of the lesion as through a stiff tube. The lumen was dilated. The normal mucosa was replaced by a coarsely granular or lace-like reticular pattern (Fig 4). The wall was 2-4 mm. in thickness. Beyond the lesion the small intestine was very motile and exhibited unusual segmentation; in places, some of the loops were temporarily dilated. There was no definite obstruction in the dilated loops proximal to the lesion, and peristaltic waves could be seen in the wall.

In the hospital the vomiting disappeared

along with the tenderness. After two weeks, tenderness had decreased sufficiently so that a rigid, L-shaped mass could be palpated.

He was discharged home and did well for about ten days. The anorexia began associated with colicky pain in the left upper quadrant. Vomiting recurred, and he was re-admitted and prepared for operation. Roentgenograms showed the persistently dilated rigid loop, which was palpable and not tender. There was no anemia. At laparotomy, multiple adhesions were found in the left side of the abdomen. Upon freeing them, a very friable, soft, thick, purplish red loop of proximal jejunum was exposed and removed with difficulty. The mesentery feeding this loop was thickened and edematous, and the same change was seen in the mesentery to the proximal jejunum as far as the ligament of Treitz. The jejunum proximal to the lesion was distended but soft and had a normal serosa. No other diseased segments were seen in the small or large intestine. The loop was completely removed and anastomosis accomplished.

Gross Pathology. *A.* The specimen (representing the involved portion of jejunum) consisted of a ragged, irregular sheet of dark red tissue. Part of it measured 11 by 3 cm. and about 0.2 cm. thick; this suggested part of the small intestine. Attached to it was a sheet of similar tissue, apparently a torn portion of intestine, measuring 9 by 3 cm. What appeared to be the mucosal surface of this specimen was dusky red and granular, with none of the usual mucosal folds. The serosal surface was likewise dull red and granular. As noted above, the wall was thinner than that of normal jejunum. *B.* Also received, a segment of jejunum 13 cm. long and about 3.5 cm. in diameter with a considerable piece of mesentery attached. Except for some roughening and reddening of the serosa on one side over the attachment of the mesentery to the intestine, the surface appeared smooth and glistening. On section the mucosa showed the usual folds and appeared intact. In the mesentery were two very hard calcified nodules, each about 1 cm. in diameter and another firm whitish one about the same size.

Microscopic Pathology. *A.* All coats, but especially the mucosa and submucosa, were infiltrated by lymphocytes, eosinophils and plasma cells. The mucosa was atrophic and in part ulcerated. Early fibrosis was noted in the submucosa. No tubercles or parasites were

seen. *B.* This part of the intestine appeared essentially negative except for eosinophils in the mucosa. A lymph node showed some fibrosis of capsule and proliferation of sinusoidal lining cells. The calcified nodules showed amorphous calcific material in lymph nodes.

Diagnosis: *Subacute jejunitis*, nonspecific, with ulceration of mucosa; chronic lymphadenitis; healed calcific lymphadenitis, probably tuberculous.

Comment. Microscopically the findings were those of a nonspecific subacute jejunitis compatible with an early stage of so-called "regional enteritis." The calcified areas were small discrete nodes in the mesentery. Regional ileitis or enteritis involving the jejunum alone is rare: Out of 507 cases collected by Ravdin,¹³ 10, or 3.2 per cent, were restricted to the jejunum. The above reported case is unique and is being reported elsewhere in detail.³

In a proved case of regional enteritis in the jejunum, the following roentgenological changes were observed over a period of weeks: persistent dilatation of a solitary loop, thickening of the wall in the involved loop, rigidity, coarse granular intraluminal surface, distention with peristalsis of the small bowel proximal to the lesion, and hypermotility and increased segmentation of the small bowel distal to the lesion.

In tumor (Case I)¹¹ and in infection (Case II), some of the roentgenological signs in the jejunum were similar. In both, the plain roentgenograms showed a distended, air-containing, elongated cavity with a thickened wall around it. The thickening was several millimeters and was due to cellular infiltration of the bowel wall.^{4,5,11,15} In both no peristalsis could be seen in the lesion, and barium rushed through it. There was no mechanical obstruction to the passage of barium through the entire small intestine.

In both diseases, the physiological activity of the adjacent small intestine was greatly altered. Peristalsis was increased throughout the small intestine in the case of tumor, and distal to the regional jejunitis. There was increased segmentation of

the barium, and transient areas of distention on serial roentgenograms. In some areas, the transverse markings were increased in width and "edematous." In Case 1, the "deficiency pattern" was simulated, though the patient was in excellent nutrition, eating well and had no anemia. It is apparent that the physiology of the entire small intestine, as exhibited with a barium medium, is altered by intrinsic disease located in a small segment of it.

A second change in small intestinal physiology was seen in Case II proximal to the non-obstructing lesion. Both the duodenum and the first 12 inches of jejunum were dilated, though exhibiting good peristalsis. A normal though distended mucosal pattern was clearly seen (Fig. 3). At operation the mesentery to the proximal jejunum was edematous, stiff, and porky. The intestine supplied by this mesentery was found to be distended on roentgen examination and at operation, but later was proved to possess a normal serosa and mucosa. This type of distention is to be distinguished from that due to obstruction and is probably due to disease in the mesentery itself. Severe dilatation of the small intestine is often seen in mesenteric artery thrombosis. Golden⁹ reported distention of the proximal jejunum in a case of regional enteritis of the lower jejunum in which there was no mechanical obstruction, and commented "that the intestine may be dilated without ileus proximal to a mechanical obstruction." The condition of the mesentery was not proved, however.

Golden distinguished a third change in small intestinal activity when only a small segment was involved in disease. A case with carcinoma of the terminal ileum showed constriction without complete occlusion of the lumen. Several dilated loops of small bowel had been previously shown by roentgen examination proximal to the lesion. He thought the change might be physiological. In summary, the motor activity and tone of the small intestine may be greatly altered by the presence of a small area of carcinoma or inflammatory

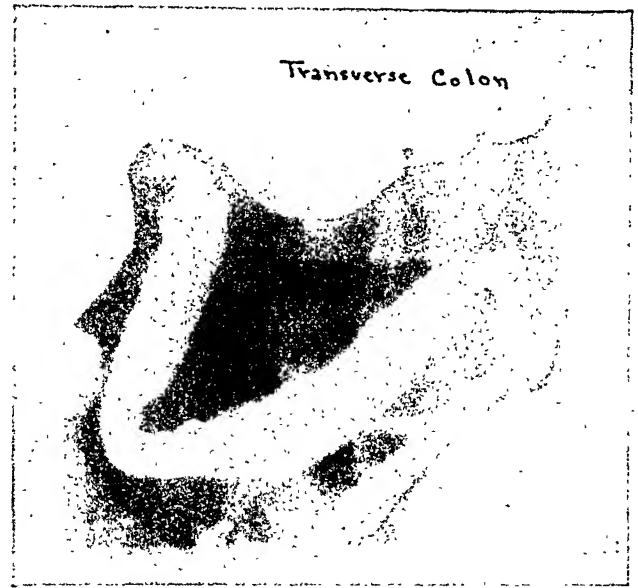


FIG. 5. Recurrent regional ileitis. Lesion extends back from ileotransverse colostomy about 24 inches.

disease without obstruction.

Differentiation between non-obstructing tumor^{4,7,14,15} and inflammatory disease^{1,2,6,13} may be accomplished before operation by a study of the intraluminal surface without and with barium. In obstruction and ileus, some of the normal mucosal markings are still visible though widely separated. In both tumor and infection, no normal mucosa is seen. A case with tumor may show a smoothed out, gently lobulated, and even slightly polypoid intraluminal surface. In a case of inflammatory disease, the intraluminal surface may be coarsely granular, lace-like or reticular. The pattern in the jejunum in our case was similar to that seen in typical terminal ileitis. Figure 5 shows the intraluminal pattern of a recurrent area of regional ileitis in the mid ileum. The distal 2 feet of terminal ileum had been resected two years previously. The recurrence was retrograde from an ileotransverse colostomy. The similarity between the intraluminal surface in Figures 4 and 5 is striking.

SUMMARY

In addition to early intestinal obstruction and ileus, dilatation of a loop of jejunum may occur with certain non-obstruct-

ing tumors and with certain infections. Associated with the latter two diseases, the roentgenological signs are rigidity, thickening of the wall, loss of normal mucosal markings, and alteration in the motor activity of the entire small bowel. Differentiation between tumor and infection may be accomplished before operation by study of the intraluminal surface of the diseased loop with and without barium.

1153 Centre St.
Jamaica Plain 30, Mass.

REFERENCES

1. BOCKUS, H. L., and others. *Gastro-Enterology* (in three volumes). W. B. Saunders Co., Philadelphia, 1946, Vol. II.
2. BROWN, S. Chronic nonspecific regional enteritis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 487-495.
3. BYRNE, F. A. Personal communication.
4. CAMERON, A. L. Primary malignancy of the jejunum and ileum. *Ann. Surg.*, 1938, 108, 203-220.
5. CHAMBERLIN, D. T. Malignant tumors of the small intestine. *Surg. Clin. North America*, 1938, 18, 705-721.
6. CROHN, B. B. Regional ileitis. *Surg., Gynec. & Obst.*, 1939, 68, 314-321.
7. CUTLER, G. D., STARK, R. B., and SCOTT, H. W., JR. Lymphosarcoma of the bowel in childhood. *New England J. Med.*, 1945, 232, 665-670.
8. FRYFOGLE, J. D., KIERNAN, P. C., and DOKERTY, M. B. Lymphosarcoma of the small intestine. *Proc. Staff Meet., Mayo Clin.*, 1946, 21, 161-169.
9. GOLDEN, R. Some problems in abnormal intestinal physiology associated with peritoneal adhesions and ileus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 56, 555-568.
10. KIEFER, E. D. The small intestine; review of recent literature. *Gastroenterology*, 1945, 5, 259-271.
11. LINGLEY, J. R. Non-obstructing malignant tumors of the small bowel. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1936, 36, 902-909.
12. MARSHALL, S. F. Regional ileitis. *New England J. Med.*, 1940, 222, 375-382.
13. RAVDIN, I. S. *Am. J. M. Sc.*, 1939, 198, 269-292.
14. ULLMAN, A., and ABESHOUSE, B. S. Lymphosarcoma of the small and large intestines. *Ann. Surg.*, 1932, 95, 878-915.
15. USHER, F. C., and DIXON, C. F. Lymphosarcoma of intestines. *Gastroenterology*, 1943, 1, 160-178.
16. WAKELEY, C. P. G., and PAUL, M. A. Tumours of small intestine (excluding adenoma). *Australian & New Zealand J. Surg.*, 1941, 1, 227-265.



ROENTGEN DEMONSTRATION OF FETAL DEATH (GAS WITHIN THE FETUS) AND UTERINE RUPTURE

A REPORT OF THREE UNUSUAL CASES

By CHARLES N. DAVIDSON, M.D.

Department of Roentgenology, University Hospital, University of Maryland

BALTIMORE, MARYLAND

WITHIN the past two years 2 obstetrical cases, very similar, have been seen, both showing evidence of gas in the fetal circulatory system. One of these cases was associated with uterine rupture. The third case demonstrates both uterine and fetal (intrauterine) gas, marked in degree, due to intrauterine infection. This latter case is included because it is unusual to have the opportunity to demonstrate such changes roentgenographically.

REPORT OF CASES

CASE I. M. K., aged thirty-eight, para 2-0-0-2, was admitted to the hospital on February 9, 1945, after having been in labor for four days without progress. The patient was referred from another, out-of-town, hospital. The past and family histories were negative. The past obstetrical history revealed two normal, spontaneous deliveries, the last occurring ten years previously. The weight of the last baby was approximately 8½ pounds.

During the present prenatal course the patient was seen for the first time when she was six months pregnant. Her blood pressure was 170/110. She was placed on a low protein and low salt diet. Following this a trace of albumin was noted in the urine on several occasions. Her expected date of confinement was January 20, 1945. She entered the out-of-town hospital on February 5, 1945, because her membranes had ruptured. Since labor did not ensue she was discharged the following day with instructions to return when labor started. She was readmitted to the same hospital Thursday morning February 6, 1945, in early labor, which progressed normally throughout the day. At 11 P.M. her doctor was called and told that she was fully dilated, the presenting part almost on the perineum, and that she could be delivered. Upon examination of the patient, the cervix was found fully dilated, but the presenting fetal part was only 1 cm. below the spines and no attempt at delivery was made.

A consultant was called and he advised pantopon gr. ½ so that the patient would rest throughout the night. A medical induction was started Friday morning, February 7. The patient's temperature at this time was 100°; pulse 120 and blood pressure 180/110. The urine showed a 1 plus albumin. The patient rested throughout the night. The medical induction consisted of castor oil, enema, and pitocin but proved ineffectual. On February 8 a roentgen examination of the abdomen revealed the fetus in right occipital anterior position with the head markedly flexed, giving the impression of a neck presentation. A catheterized specimen of urine on Saturday showed gross blood and a 4 plus albumin. The blood pressure was 170/110 at this time. The consultant was again called and he advised another medical induction to be started Sunday morning, February 9. This was given without any change noted, consequently a second consultant was called. The latter consultant advised transferring the patient to a hospital in Baltimore.

On admission to University Hospital at 4:30 P.M., February 9, the patient appeared quite toxic, moderately jaundiced, her temperature was 99.8° F., pulse 128, respiration 28 and blood pressure 185/108. An abdominal examination revealed the height of the fundus to be 31 cm. The back could be felt in a right occipital anterior position. However, the abdomen was moderately tense and palpation of the fetus, especially the head, was quite difficult. There was some question as to whether the fetal heart could be heard. She was given pantopon gr. ½ and 1,000 cc. each of 5 per cent glucose and normal saline. One hour later she was referred for a roentgen examination of the abdomen. This revealed a markedly distended abdomen, the presence of a single fetus in transverse position, the fetal head very large and lying in the right iliac fossa. Gas was present within the fetus conforming to the distribution of the liver vessels, heart and aorta. A large mass was present in the mid upper abdomen, the right border of it being well defined. An impression

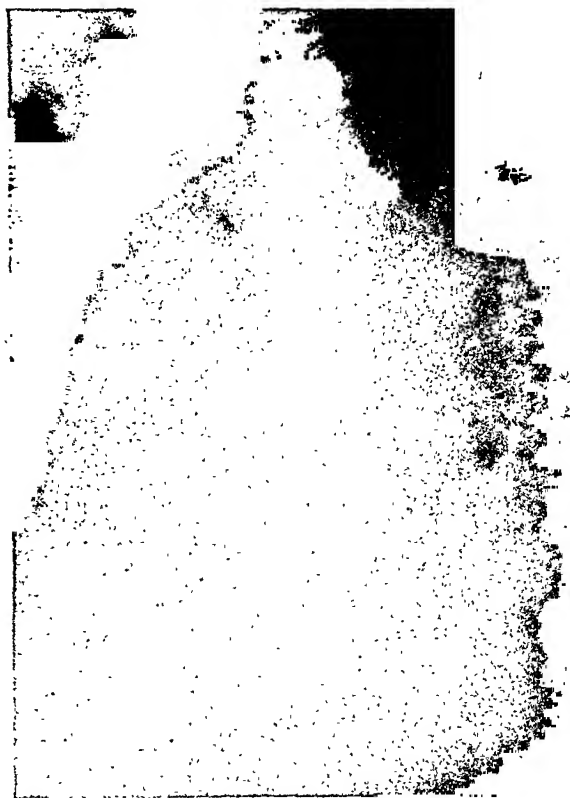


FIG. 1. Case 1. Anteroposterior roentgenogram of the abdomen showing a large mass (uterus) in the upper abdomen. The right border lies just medial to the distended ascending colon. Hydrocephalic fetal head overlying right ilium and sacrum. Paravertebral mass (retroperitoneal hematoma) to the right of eleventh and twelfth thoracic vertebrae.

of a hydrocephalic fetus and fetal death was made. The exact nature of the mass was not determined but was thought to be associated with the uterus (Fig. 1 and 2).

At 8:00 P.M. the patient was given a general anesthetic, the hydrocephalic fetus was removed from below by a destructive operation. Palpation of the uterus following delivery revealed a large rent in the anterior uterine wall extending from the cervix to the fundus. A laparotomy was then performed. Upon opening the abdomen the placenta was found free in the abdominal cavity with approximately 2,000 cc. of blood. The presence of a ruptured uterus was confirmed and the tear in the uterus appeared to be an old one. A supravaginal hysterectomy was done. The patient received 5 pints of citrated blood and 1 pint of plasma during the operation. The postoperative course was rather stormy and she died the third day after the operation.

Autopsy permission was granted and the findings were as follows: Traumatic, vesicovaginal fistula, intrapartum; retroperitoneal

hematoma; hydronephrosis, hydroureter, right; hydrohematoperitoneum, 2,500 cc.; jaundice, skin and mucous membrane; fibrinous peritonitis, generalized; lower midline incision, recent; passive congestion, lungs; pulmonary infarcts, left multiple. The fetus was disposed of immediately after delivery, hence postmortem studies of it were not possible. An attempt to determine the type of gas present within the circulatory system of the fetus would have been helpful.

CASE II. R. S., a colored female, aged twenty-three, was first seen in the obstetrical clinic on July 15, 1946, at which time a diagnosis of pregnancy was made, duration approximately six months. As two blood Wassermann reactions were found to be strongly positive the patient was referred for rapid luetic therapy.

A past obstetrical history revealed one full term living child delivered in 1942 without complications. The patient visited the clinic at rather regular intervals and on September 30, 1946, for the first time the fetal heart sounds were not heard. On this same date the abdomen was found to be rather large and out of proportion to the duration of pregnancy. Polyhydramnios was suspected and the patient was referred for roentgen examination. This revealed a fetus of approximately eight months' duration with suggestive overlapping of the cranial bones. The uterus seemed quite large, larger than normal for the fetal size, and a

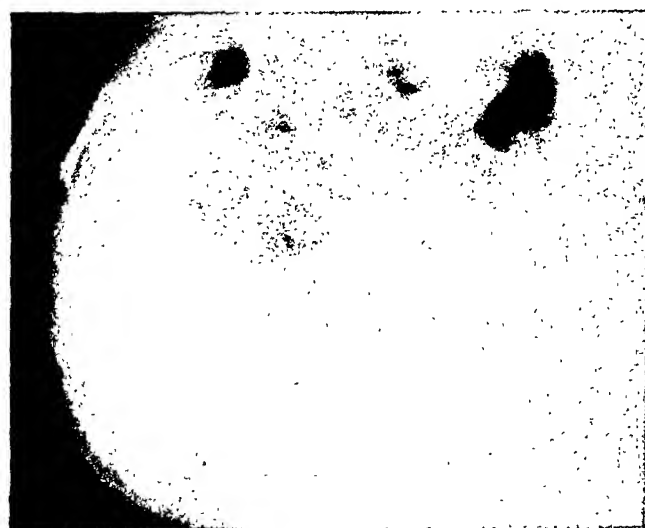


FIG. 2. Case 1. Lateral roentgenogram of the abdomen demonstrating gas in the fetal circulatory system. The large collection is within the heart. Other globules are noted in the thoracic aorta and abdominal vessels.

roentgenological impression of hydramnios and probable fetal death was made. No gas was noted in the fetal circulatory system. On October 11, 1946, the patient was admitted to the hospital because of slight vaginal bleeding. As roentgen. placental visualization is done routinely on patients bleeding in the last trimester, the patient was again referred for roentgen examination. At this time well demonstrated gas was noted in the vessels of the liver, great abdominal vessels as well as the heart. The fetus assumed a rather relaxed position, the uterus was very large and the placenta was located in the anterior fundus. The fetal long bones were well demonstrated and practically all showed areas of marked decalcification adjacent to the epiphyses, with slight condensation of bone on the opposing surfaces. An impression of definite fetal death was made. The changes in the fetal long bones were thought to be due to lues (Fig. 3). Within the next few hours the patient went into labor. Labor was rather prolonged, lasting thirty-nine hours and twenty-two minutes. A 7 pound dead fetus was delivered. The puerperium was entirely normal and the patient

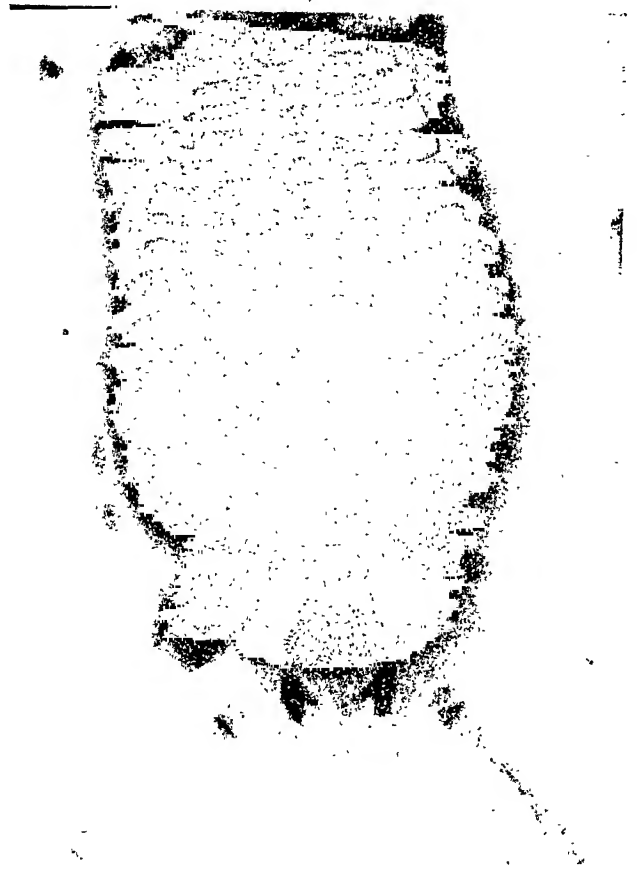


FIG. 4. Case II. Anteroposterior view of the fetus immediately after delivery showing gas in the circulatory system similar to Figure 3. (Film in reverse position.)

was discharged from the hospital nine days later.

A roentgen examination of the fetus after delivery showed similar distribution of gas as previously described as well as a clearer demonstration of the bone changes (Fig. 4 and 5). A postpartum examination of the fetus showed marked maceration with generalized autolysis of the viscera. An attempt was made to collect gas from the vessels for study but due to the small amounts present and technical difficulties encountered none was obtained. A section of a femur was removed for study but the pathologist was unable to find any definite abnormality. The cause of death was attributed to lues.

CASE III. M. W., a colored primipara, aged thirty-two, was admitted as a registered service patient on February 26, 1947, at term, not in labor, and with the membranes ruptured since 4 P.M. on February 25. The patient was admitted with a diagnosis of premature rupture of membranes for normal, routine delivery.



FIG. 3. Case II. Lateral view of the abdomen demonstrating gas in the fetal circulatory system: heart, abdominal vessels and umbilical cord. The uterus is quite large and the fetus assumes a relaxed position due to hydramnios. The placenta is attached to the anterior uterine wall.



FIG. 5. Case II. Showing bone changes in lower extremities of the fetus. Zones of decalcification with adjacent increased bone density in the ends of the long bones.

Her family and past histories were non-contributory. The prenatal course was essentially normal with the exception of a large granulomatous lesion of the right and left labia which was diagnosed as granuloma inguinale in the skin dispensary where she was followed throughout her pregnancy. On admission to the hospital the urine was negative; hemoglobin 90 per cent, blood pressure 104/56, temperature 99.8° F., respiration 20, pulse 88. The fetus was in the left occipito-anterior position with the presenting part fixed. Fetal heart sounds were heard in the left lower quadrant. On February 27 the patient's temperature rose to 102.6° F. The white blood cell count was 14,200, the urine was negative. A diagnosis of antepartum infection was made at this time and the patient was placed on routine chemotherapy (penicillin and sulfadiazine). Sulfadiazine was discontinued on February 28 because of a developing anuria. The blood pressure still remained normal. The fetal heart sounds were last heard at 1 P.M. on February 28. Although the temperature improved in the evening of that day, the patient appeared toxic and routine parental fluids were started. At 1 A.M. on March 1, the

patient was acutely distended. Gastric suction was started and a temporary diagnosis of paralytic ileus was made. The patient did not improve and the temperature gradually rose to 102° F.

A roentgen examination made on the afternoon of March 1, revealed a large amount of intrauterine gas causing marked distention of the uterus and separating the uterine wall from the fetus (Fig. 6 and 7). Similarly there was gas seen throughout the tissues of the fetus: intracranial, intrathoracic, intra-abdominal, subcutaneous and intramuscular. The fetus appeared to be full term, in right occipito-anterior position and obviously dead. Following this information supportive measures were continued.

An emergency blood chemistry on March 1 showed urea nitrogen of 23. A rectal examination revealed the cervix one finger tip dilated, the presenting part 1 cm. above the spines and the cervix 25 per cent effaced. The patient gradually grew worse and her urea nitrogen rose to a maximum of 77 on March 5. A pelvic examination on the night of March 3 revealed crepitation of the cervix. On March 4 a sterile pelvic examination was repeated, amniorrhexis performed and a scalp clamp applied. On March



FIG. 6. Case III. Anteroposterior view of the abdomen, showing large amount of intrauterine gas and gas throughout the tissues of the fetus.

5 the patient finally began to void and she began to improve slightly, her urea nitrogen being 62 and uric acid 12.8 the following day. Uterine cultures on March 3 revealed microaerophilic gamma streptococcus. The urine culture of March 1 was negative. On March 6 at obstetrical conference a decision was made to deliver the patient from below in view of the optimum improvement. Accordingly, on March 6 the patient was given a general anesthetic and delivered from below by a destructive operation. The fetus on delivery was considerably macerated and decomposed and the umbilical cord had completely sloughed away. (Fig. 8 is a roentgenogram of the fetus immediately after delivery.) During the procedure approximately 2,000 cc. of foul smelling pus and decomposed debris escaped from the uterine cavity along with a quantity of equally foul smelling gas. Exploration of the uterine cavity after delivery revealed no tears. Cultures taken at the time of delivery from the placenta and baby revealed pure cultures of *B. coli* in heavy growths.

Following delivery the temperature remained around 102° F. and returned to within normal limits on her second day. However, there were some remissions and exacerbations of her temperature, the high being 101° F. on her fifth and



FIG. 8. Case III. Fetus immediately after delivery, demonstrating gas throughout all tissues.

sixth postpartum days. This was associated with foul, scant lochia which when treated with chemotherapy, ergotrate and Dakin's solution to the perineum q.i.d., gradually returned to normal. The patient was allowed up on her seventh postpartum day and was discharged in an improved condition on March 16, 1947, her tenth day, with a diagnosis of (1) puerperal endometritis, (2) stillbirth, cause of death—*intrauterine asphyxia, secondary to intra-partum infection.*

DISCUSSION

Cases I and II demonstrate very well the presence of gas in the fetal circulatory system. Attention was first called to the roentgen demonstration of this condition by Roberts¹ in 1944. He reported 2 cases both showing similar distribution of gas in the fetal circulatory system. He contributed this as a new sign of fetal death. He gave no explanation as to the source or cause of the gas but stated that further investigation along this line would follow. In the 2 cases presented here likewise no definite cause for the gas was found. Presumptive evidence would lead one to think



FIG. 7. Case III. Lateral view of the abdomen, showing distention of the uterus by gas and better visualization of gas in the tissues of the fetus.

that it is due to decomposition of blood elements. The first fetus was destroyed before any studies could be made and attempts to do the same on the second fetus were unsuccessful. Certainly the presence of gas in the circulatory system must be a late sign of fetal death.

Although many articles have appeared in the literature concerning the diagnosis of uterine rupture, little has been mentioned regarding the roentgen observations. Hoffman,² in one of his case reports, makes this statement: "X-ray examination revealed the fetus high in the pelvis with a soft tissue tumor filling the pelvis, separate from the fetus. The diagnosis was 'ruptured uterus.'"

Failure to include a roentgen examination in this condition may be easily attributable to the fact that most patients with uterine rupture are readily diagnosed clinically by the obstetrician and the condition is treated as an emergency. Time consumed by roentgen studies would further endanger the life of the patient. However, there is a small group of these cases where the diagnosis is not very clear-cut, perhaps only suggestive, or not evident at all. Here, a roentgen examination may prove invaluable, especially if the tear in the uterus is great enough to permit the fetus to enter the abdominal cavity. The roentgen findings, as demonstrated in this case, are:

1. The presence of a well defined mass in the abdominal cavity, the contour of which suggests a contracted uterus.
2. The fetus outside the confines of this mass.
3. The absence of a uterine wall circumscribing the fetus.
4. Unusual position of the fetus.

Another change which may have been present but not demonstrated is the presence of free gas in the peritoneal cavity. Although the diagnosis of uterine rupture was not suggested at the time of the initial roentgen interpretation, a review of the

case brought out the absence of a uterine wall circumscribing the fetus.

The third case is one of uterine distention with gas associated with generalized fetal gas due to infection. The organism producing the gas is an anaerobic streptococcus. Jordan and Burrows³ state that this type of organism has been found producing puerperal sepsis and is gas forming and usually non-hemolytic.

SUMMARY

Three cases are presented as follows:

1. Uterine rupture with roentgen manifestations of the same, associated with evidence of gas in the fetal circulatory system.
2. Fetal death in utero demonstrated by gas in the fetal circulatory system.
3. Puerperal sepsis with roentgen manifestations of gas in the uterus and fetus, the gas being produced by a gas-forming organism.

CONCLUSIONS

1. The inclusion of roentgen examinations in cases of questionable ruptured uterus may prove helpful in arriving at a diagnosis.
2. The fetus in utero should be inspected closely for the presence of gas in the circulatory system. If present it indicates fetal death.
3. Roentgen examinations in cases of abnormal abdominal distention associated with puerperal sepsis may prove useful in eliminating other causes for distention.

University Hospital
Baltimore 1, Maryland

REFERENCES

1. ROBERTS, J. BOYD. Gas in the fetal circulatory system, a sign of intrauterine fetal death. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 631-634.
2. HOFFMAN, W. E. Ruptured uterus. *West Virginia M. J.*, 1939, 35, 74-76.
3. JORDAN, E. O., and BURROWS, WILLIAM. *Textbook of Bacteriology*. Fourteenth edition. W. B. Saunders Co., Philadelphia, 1945, p. 324.

SARCOMA OF THE URINARY BLADDER IN CHILDREN*

WITH A REVIEW OF THE LITERATURE

By GEORGE W. HENRY, M.D.†

BRYN MAWR, PENNSYLVANIA

TUMORS of the urinary bladder in children are rare and nearly always malignant in nature. Not only are few found in the literature, but almost all are reports of single cases. Six authors have reported 2 cases each and none have reported more than this number. Most pediatricians have not seen a bladder tumor, and few urologists or radiologists have had experience with this type of neoplasm in children. For this reason a report of 2 additional cases with a review of the literature would seem to be timely.

Eighty-nine cases of malignant bladder tumors in children under ten years of age were found in the literature. Deming⁶ reviewed 55 cases in 1924, and of Crane and Tremblay's⁵ cases in 1943, 20 were in this age group. Fourteen others have been reported since. Adding the 2 cases reported in this paper to those from the literature, the total is brought to 91 cases.

PATHOLOGICAL FINDINGS

Malignant bladder tumors in children are all of mesodermal derivation. A few benign papillomas have been reported, but no authenticated instance of carcinoma. In Table I are listed the various types of sarcomas of the bladder found in the literature. According to Ewing⁹ they may be classified histopathologically as angio-, chondro-, fibro-, glio-, lipo-, myo-, myxo-, neuro-, and osteo-sarcoma. Approximately 60 per per cent of the cases were found to be myxosarcoma, myxoma, or classified as just sarcoma. Many of the latter would probably fall into a more specific group if they were reviewed in the light of the classification of the present day. The histopatho-

logical picture in each form varies as to the type of cell present. It is beyond the scope of this paper to discuss the microscopic details of each, but they all present a picture of an embryonal sarcoma with variations according to the dominant cell types

TABLE I
TYPES OF SARCOMA OF THE BLADDER AS FOUND
IN THE LITERATURE

Type	Cases	
	No.	Per Cent
Sarcoma	28	31.0
Myxoma	15	16.4
Myxosarcoma	11	12.1
Rhabdomyosarcoma	9	9.9
Fibrosarcoma	8	8.7
Lymphosarcoma	4	4.3
Rhabdomyomyxosarcoma	3	3.3
Leiomyosarcoma	3	3.3
Fibromyxosarcoma	2	2.2
Rhabdomyoma	2	2.2
Spindle cell sarcoma	2	2.2
Embryoma	1	1.1
Neurogenic sarcoma	1	1.1
Osteogenic sarcoma	1	1.1
Plexiform neurofibrosarcoma	1	1.1
Total	91	100

(Deming⁶ and Ewing⁹). The myxosarcoma, for example, is a rather cellular structure with round or spindle-shaped cells which are suspended in a homogeneously staining material. This background material is not unlike the gelatinous substance found in the umbilical cord. In it, blood vessels are thin walled and are often numerous.

These tumors are always highly malignant despite the fact that they rarely metastasize. If metastasis does occur, it is

* From the Departments of Radiology, The Children's Hospital, Philadelphia, and The Bryn Mawr Hospital, Bryn Mawr, Pennsylvania.

† Now at Stanford University School of Medicine, San Francisco, Calif.

late. Wheelock,³⁰ in a discussion of sarcomas of the bladder which included and stressed adult cases, states that 23 per cent metastasized to the aortic nodes, liver, and lungs. Even this relatively low figure is not borne out in children, possibly because of their early death. Deming emphasizes the infrequent metastases in his series of 55 cases. Crane and Tremblay⁵ list only 3 cases in children that had metastases, 1 to the peritoneum and 2 to the lungs. No mention has been made of metastases in any of the other reports of cases in the literature although autopsy examinations were recorded in most instances. In contrast, these sarcomas invade by direct extension. The neighboring vagina, uterus, prostate, pelvis or abdominal walls are involved with a startling rapidity. The ureters are often occluded at the vesical orifice, but extension of the tumor to the upper ureters has not been described. These lesions all grow rapidly and consistently recur following removal.

Grossly the vesical sarcomas are usually soft, friable, vascular, and hemorrhagic. They vary from polypoid, pedunculated, sessile, to massive in size and shape. Their surface is smooth and glistening, and except for occasional ulcerations these neoplasms are covered with bladder epithelium. Rhabdomyomyxosarcomas have consistently been described as a "bunch of grapes" or like a hydatidiform mole. Otherwise the gross appearances are not characteristic. These lesions have usually infiltrated beyond their apparent visible or palpable limits. In Case 11 the whole bladder wall was microscopically involved, despite its grossly normal appearance. Similar findings were present in several of the cases reported in the literature.

The location of the neoplasms in the bladder is highly pertinent. They involved the trigonal area or were widespread throughout the bladder in 65 per cent and involved the walls only in 35 per cent of the cases. Many of the latter were also located near the urethral or ureteral openings. This basal distribution makes com-

plete surgical extirpation difficult or impossible short of a cystectomy.

The age and sex distribution are given in Table II. Seventy-five per cent occurred in children five years old or younger, and 40 per cent in infants two years or under, indicative of a definite predominance in younger children and infants. The youngest case occurred in a three day old boy.¹⁴ Of the 91 cases, 58 were in males, 19 in females, and in 14 the sex was not stated.

TABLE II
AGE AND SEX

Age, Yr.	Male	Female	Sex Not Stated	Total
Under 1	7	1	4	12
1	6	4	1	11
2	11	1	3	15
3	6	2	3	11
4	8	4	1	13
5	5	3	0	8
6	7	1	0	8
7	3	2	0	5
8	0	0	0	0
9	3	0	0	3
10	2	0	1	3
A child	0	1	1	2
Total	58	19	14	91

These vesical sarcomas showed a preference for boys in a ratio of three to one.

The predilection for the infant would suggest the congenital or "cell rest" theory of pathogenesis. There were no other findings which would further substantiate the varied hypotheses formulated to explain the development of these tumors. One factor of importance, however, has been the involvement of the bladder only, in many cases without extravesical tumor, which rather disputes the theory that the sarcomas arise solely from the perivesical tissues, as suggested by some authors.²²

SYMPTOMATOLOGY

The early symptoms were predominantly those due to vesical irritation: frequency, dysuria, urgency, incontinence, or enuresis. Hematuria occurred in a large majority of the reported cases, at times

early but usually late. Most often bleeding was intermittent but occasionally it was gross and excessive. Pain was also variable in degree and type, but usually it occurred in a suprapubic site and was worse on micturition. Infection, with pyuria, was prone to develop early. This often resulted in a diagnosis of uncomplicated cystitis, with a resultant delay in further diagnostic studies. The great majority of cases were not seriously considered until urethral obstruction intervened. The time such obstruction appeared was variable, and frequently it was the presenting complaint. A large suprapubic mass appeared with a regular frequency, either from a distended bladder, actual tumor mass, or both. Following these vesical symptoms, which sometimes were present for a few days to months, renal infection and failure appeared and symptoms of these dominated the picture thereafter. In other instances, the latter were the initial symptoms. The course was then rapidly retrogressive, with uremia, systemic infection, and death.

DIAGNOSIS

The history indicated involvement of the urinary tract. Abdominal palpation often revealed a suprapubic mass, the bladder distended with urine and (or) tumor. Bimanual rectal palpation was informative, a procedure too often neglected because of the child's or the parents' objections. Urinalysis showed the presence of infection with bacteria, white blood cells, and usually red blood cells. Fever and an elevated white blood cell count were almost constantly present. Roentgen examination ruled out opaque calculi and in one case showed a mottled calcification due to calcareous deposits on a slowly-growing myxoma.¹⁸

Urographic and cystographic studies could, as a rule, establish the presence of a tumor. Cystography using air instillation, followed by contrast medium, was more satisfactory. The neoplasm when contrast medium was employed caused a filling defect, usually basal in location, and often multiple. With air and profile views the

tumor was frequently directly visualized. Local or generalized irregularity of the walls plus a small bladder capacity implied infiltration of the whole bladder. Ureteral reflux occasionally was found with ureterectasis. Cystography proved to be a safe and simple procedure at all ages. It involved essentially no risk, and it is desirable that cystography precede cystoscopy. Caliectasis, pyelectasis, and ureterectasis, with poor kidney function, were often demonstrated with urographic studies, as well as deformity of the bladder, displacement, and filling defects. Non-visualization was not uncommon due to poor kidney function or (and) excess gas shadows, especially in the infant.

Cystoscopic examination was confirmatory and some tumors were found that were not otherwise visualized. In several instances, however, this procedure caused severe hemorrhage.¹⁹ Occasionally it was impossible to outline the tumor or differentiate it from prostatic enlargement.^{1,28} In Case 1 cystoscopy led to a definite delay in treatment as negative results were obtained on three separate occasions. A specimen for microscopic study could usually be obtained during cystoscopic examination. This procedure proved to be essential in excluding benign tumors, such as angioma, fibroma, myoma, dermoid, and papilloma, which presented the same gross appearances as the sarcomas. The benign tumors were more uncommon.⁴ Deming found an incidence of 20 per cent. Cystotomy was at times necessary to secure material for histopathological study.

PROGNOSIS

The prognosis was uniformly grave. The very rapid rate of growth often resulted in early urethral or ureteral obstruction with kidney damage and infection before the diagnosis was suspected. The pyelonephritis and pyelectasis were followed by uremia, cachexia or intervening systemic infection, and death. The average case died within six months, and survival of more than a year was unusual. These early and

rapid deaths occurred despite surgical intervention and extirpation of the neoplasm. Recurrence after excision was not only the rule, but surgical trauma seemed to act as a stimulus and increased the rate of growth.

Uhlmann, Grossman and Calvin²⁶ reported a case of a sarcoma which was excised from the bladder of a ten year old boy. In one week it had recurred to the

living two years.¹² Feggetter's case had lived one year when reported. A personal communication reveals that she is now a healthy young woman, twenty-two years of age, with an apparently normal bladder, twelve years after treatment. Of interest is the fact that she married and conceived, despite her roentgen therapy. Evidently the ovaries were not irreparably damaged.

TABLE III

CASES LIVING AT THE TIME OF THEIR REPORT IN THE LITERATURE

Author	Date	Type	Therapy	Course
1. Deschamps ⁷	1791	Fibrosarcoma	Resected	Alive
2. Klein ¹⁶	1895	Polypoid sarcoma	Resected	Alive
3. Mixer ²⁰	1917	Embryoma	Tumor and base excised	Well at 2 years
4. Feggetter ¹⁰	1937	Sarcoma	Tumor and base excised plus deep roentgen therapy	Cured, 12 year survival
5. Hess ¹¹	1938	Plexiform neurofibrosarcoma	Partial resection and some roentgen therapy	Alive 7 years with disease
6. Meade ¹⁸	1943	Polypoid myxoma	Tumor and base excised	Alive and well
7. Tahara, Burt and Hess ²⁵	1945	Fibromyxosarcoma	Resection plus deep roentgen therapy	Well at 3 months*

* Died after surviving 2 years.¹²

extent that it was protruding from the operative site.

The following cases were alive at the time they were reported. Hess's plexiform neurofibrosarcoma was living at seven years with known residual disease. It undoubtedly was a slowly growing lesion and it did not behave in a manner comparable to the other cases. The short follow-up period in 5 of the other cases and also in Case 11 in this paper was not entirely satisfactory. Cases 1, 2, 3, and 6 (Table III) were located high on the bladder wall or in the fundus, which permitted wide excision through healthy tissue. As a result they may have resulted in actual cures. The study of the other reported cases with similar excision, however, does not confirm this favorable prognosis. The 2 remaining cases, Case 5 (Feggetter)¹⁰ and Case 7 (Tahara, Burt and Hess)²⁵ in Table III, in addition to excision, received deep roentgen therapy. Tahara, Burt and Hess's case, though well at the time of its reporting, died after sur-

Irradiation seems to have delayed recurrences in Tahara, Burt and Hess's case, though the patient ultimately succumbed. In the case reported by Feggetter the combination of excision and roentgen treatment resulted in the only conclusive cure reported in the literature.

If 6 of these cases are considered cures, the mortality rate was 93 per cent. The actual rate was probably higher than this when the short follow-up period and the unreported cases are taken into consideration. From this review, except for the one case above, no mortality rate can be given in terms of five year cures with a tumor-free patient. Sarcoma of the bladder is one of the most malignant tumors that occur in children.

THERAPY

The early cases in the literature had excision or curettement of the tumors with and without excision of the bases. The great majority in the last half century were treated by excision and, where possible,

resection of adjacent, presumably normal, bladder tissue. In lieu of the latter, cautery of the base was performed in lesions located in the trigone. Radium implantation was occasionally added. Suprapubic drainage was the rule for urethral obstruction. With these methods, fulminating recurrences developed with a regular and distressing frequency. An example is the case of Welfeld, Hill and Hillebrand.²⁸ A rhabdomyomyxosarcoma was "pulled" from the bladder wall near the urethral orifice. Three days later when the suprapubic catheter was removed, the tumor had again filled the bladder. The neoplasm then bulged out through the excision, and the external mass reached the size of a grapefruit in ten days.

Because of these poor results, Campbell,³ Deming,⁶ Tahara, Burt and Hess,²⁵ and many others, have condemned excision, except for the occasional isolated tumor located near the fundus where a wide border of healthy tissue can be included. Multiple biopsies of the remaining "normal" bladder to exclude microscopic infiltration of the other walls and base can be performed. Postoperative radiation therapy should follow.^{3,5,25} In the typical cases with a trigonal location of the sarcoma, radical methods are recommended. Deming⁶ in 1924 suggested cystectomy as a possibility, but knew of no case in a child where it had been tried. Crane and Tremblay⁵ stated that cystectomy, radium, and roentgen therapy offered the only promise of alleviation or cure. Cecil,⁴ Campbell,³ Ratliff and Valk,²³ Weyerbacher and Balch,²⁹ and others, stated that complete cystectomy was the therapy of choice. Khoury and Speer¹⁴ performed a cystectomy on a five and a half month old child who had symptoms from the age of three days. The ureters were transplanted to the skin, the bladder removed, and later the ureters placed in the sigmoid. The patient died six and a half months later with kidney failure and infection. Despite ultimate death, the operation was a success in that the patient withstood the procedure satisfactorily. Kidney damage and infection in this case

was too great before the operation was undertaken. Ritter and Kramer²⁴ stated that the operative shock should be no more than that from a prostatectomy in an adult, and it should not be considered an impossible or too formidable procedure. The general opinion of the writers in the literature concurred in this method, and stressed the need for the procedure as soon as the diagnosis was established. Their decisions for cystectomy were unfortunately formulated after the autopsy, and as a result it has had relatively little trial in children.

A comparatively small number of cases have had roentgen therapy. Radon seeds have been used in several cases to the base of the excised tumors.^{3,6,19,23} This type of irradiation has proved unsatisfactory, largely because of the extent of the neoplasms. Teleradium and deep roentgen therapy have been used in a small number of patients. Rhabdomyomyxosarcoma and spindle cell sarcoma are radioresistant but do show some response in that they may be temporarily held in check.^{14,21,26} Sarcoma, myxosarcoma, fibromyxosarcoma, fibromyxoma, and myxoma have all been shown to be more responsive and appear to be moderately radiosensitive.^{1,3,5,6,10,11,14,25,27,29} Tahara, Burt and Hess, who had a living patient at the time of their report, gave 2,100 roentgens anteriorly and 2,400 r posteriorly, measured in air, as a postoperative course. Hess believes radium and roentgen irradiation should be of great therapeutic aid and strongly recommends its use. Crane and Tremblay, Khoury and Speer, and the above-mentioned writers, feel that these rapidly growing neoplasms are definitely sensitive enough to give promise with roentgen therapy. Kikuti and Minakawa¹⁵ reported an ovarian fibromyxosarcoma completely destroyed locally by roentgen treatment, though metastases appeared elsewhere eight months later. The dosage used was not given. In Case II, as reported in this paper, it is difficult to assay the effect of the roentgen treatment as it was always given in combination with excision. Nevertheless, the sarcoma seemed to have

been held in check somewhat for two months on two occasions, and from the cases in the literature with excision alone, one would not expect relief for this short period.

In a discussion of the most beneficial therapy the behavior and characteristics of this group of neoplasms must be recalled. Metastases occur rarely and late. This reluctance to metastasize offers an opportunity for treatment not found in the usual malignant condition. The exceedingly rapid growth, local invasion, recurrence following resection, early interference with kidney function plus infection dominate the picture. A multiple attack is required to meet this, and in a favorable case it can be attempted.

In the uncommon, isolated, and localized fundal sarcomas, wide excision, multiple biopsy of the remaining bladder wall, and deep postoperative roentgen therapy are practical and desirable. The patients must be followed closely with repeated cystograms and occasional cystoscopic examinations. In the typical case with infection, obstruction, and a trigonal sarcoma, excision is contraindicated. Antibiotics, suprapubic cystotomy for drainage, and general systemic care should be instituted and are necessary to sustain life. As soon as the diagnosis is established, and the child is no longer acutely ill, deep roentgen therapy can be instituted. Deep roentgen therapy should be given to skin tolerance through at least two ample ports. Damage to testicular, ovarian, or bony epiphyseal tissues can be disregarded. A depth dose of 3,000 r would seem desirable. Early radiation treatment is preferable before contemplating surgical procedures. Since genitourinary tract infection and renal damage are usually present, radical surgery, if not entirely contraindicated at this time, will certainly add to the strain on the child and is best delayed. In addition, ureteral transplantation in the presence of infection is doomed to failure, but may be performed later with more hope of success.

Following treatment with general meas-

ures and radiation therapy, careful evaluation of the patient's condition can be made. The amount of kidney damage must be accurately determined. If definite renal failure is present and has persisted, palliative measures only need be considered. If kidney function is satisfactory and infection controlled, further treatment of the sarcoma may be feasible. The neoplasm will possibly have been reduced in size, in accordance with cases reported in the literature. The relatively resistant types of sarcomas will most likely have been held in check and the others will have shown varying degrees of regression and partial destruction. Except for the lymphosarcoma, which will grossly have disappeared, this amount of radiation will not cause a complete disappearance of the tumor. Roentgen treatment alone cannot result in the entire destruction of these neoplasms. For this reason a complete cystectomy should follow. This is a radical form of therapy for an adult, and especially so in an infant or a child. However, since invariable failure resulted from other operative procedures, cystectomy offers the only hope for a cure. Cystectomy is being performed successfully in adults, and Khoury and Speer¹⁴ have demonstrated its feasibility in an infant under adverse conditions. They recommend ureteral transplantation to the skin, cystectomy including the prostate and proximal urethra, and at a later date, transfer of the ureters to the sigmoid. Obviously it is no small matter to doom a child to a lifetime without a urinary bladder or to subject him to such a major operative procedure, but it offers him his only chance of relief from an otherwise hopeless lesion. Two to four months following operation, a second series of roentgen treatments can be given.

With the mortality rate of over 90 per cent for sarcomas of the bladder as a whole and 100 per cent for trigonal lesions, one cannot become optimistic over any method or plan of therapy. Despite this, and the many certain failures that can be expected from such a formidable neoplasm, the lit-

erature has conclusively demonstrated that therapeutic measures short of those discussed here have invariably met with failure.

REPORT OF CASES

CASE 1. J. S., a colored male, aged twenty-one months, was admitted on May 4, 1946, to the Children's Hospital with a past history of six weeks' duration of progressive frequency, dysu-

obviously seriously ill. The hematuria had continued intermittently. Visualization of a bifid left kidney pelvis and proximal ureter was obtained on urographic study and the bladder tumor was again demonstrated (Fig. 2). The latter had increased in size with apparent involvement of the entire organ. A suprapubic mass was easily palpable clinically. Two further cystoscopic examinations were also negative, though the operator was not entirely satisfied.

Suprapubic cystotomy demonstrated a lobu-

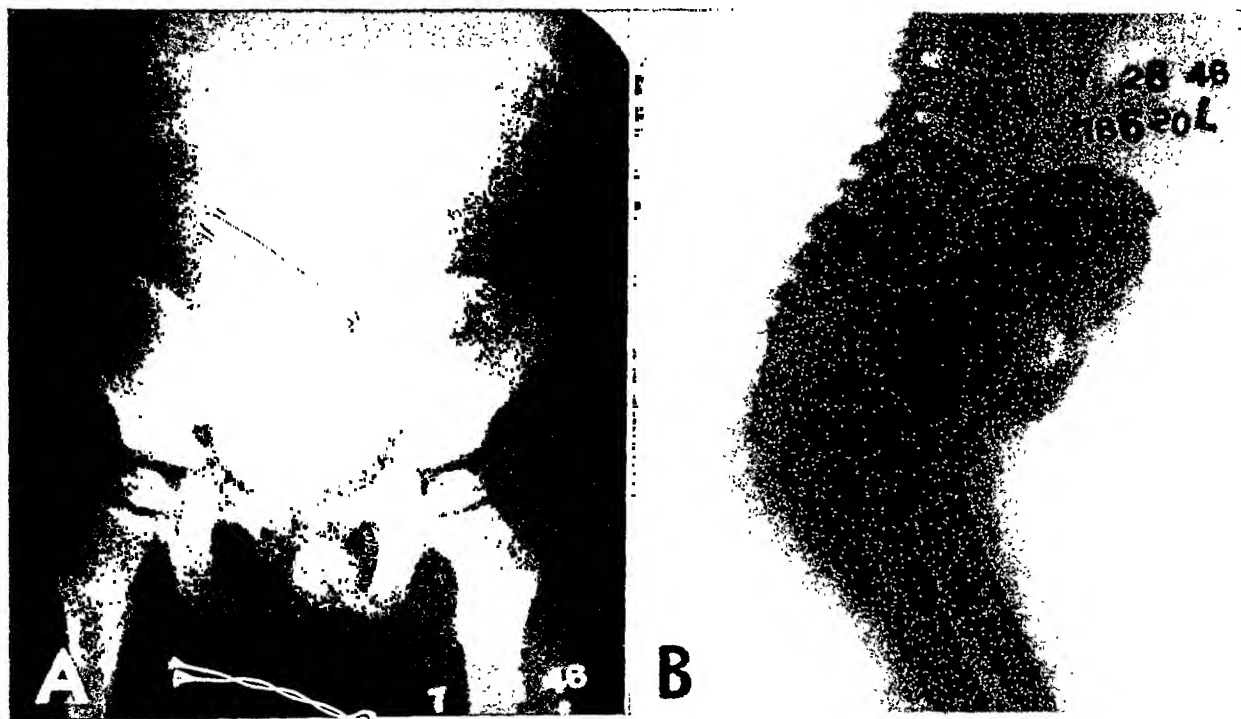


FIG. 1. Case 1. (A) Cystogram demonstrating a large filling defect typical of a neoplasm. (B) Lateral view.

ria, straining, and a mucoid discharge from the urethra. He passed bright red blood the day before admission.

Physical examination, including abdominal and bimanual rectal palpation, was negative except for an inflamed glans penis. The urine showed white blood cells, red blood cells, and a positive culture for *Bacillus coli*.

A urogram was unsatisfactory. A cystogram demonstrated a space-occupying lesion, typical of a bladder tumor (Fig. 1, A and B). Cystoscopic examination was negative, though not entirely satisfactory due to blurred lenses. The patient was then signed out of the hospital against advice.

On readmission six weeks later, there was a marked increase of the previous signs and symptoms, plus fever and chills. The child was

lated, glistening, and hemorrhagic large tumor mass located largely in the trigone area, though it obviously involved the whole bladder. Biopsy only was attempted.

The tumor cells on microscopic examination were round and oval, deeply staining, and in a myxomatous background. A few mitotic figures were present. Pathological diagnosis: Myxosarcoma (Fig. 3).

The patient was again signed out of the hospital against advice, and he died five months after his first admission. Death was presumably due to kidney infection and failure, which was present during his last hospital stay. No metastatic lesions were demonstrated during the period of observation by physical examination, roentgen examination of the chest and long bones, or exploratory operation.



FIG. 2. Case I. Intravenous urogram showing a bifid left kidney pelvis and ureter as well as the myxosarcoma of the bladder.

CASE II. C. H. (No. 064288), a white male, aged fifteen months, was admitted on June 24, 1947, to the Bryn Mawr Hospital with apparent abdominal pain of four hours' duration and a "lump" in the right scrotum. The patient had been voiding frequently and in small quantities for the past few weeks. Urinalysis and blood counts were within normal limits. A right hydrocelectomy and herniorrhaphy were performed following a five day observation period. The patient was discharged apparently well eight days after operation.

Two days latter the patient was readmitted with incontinence, dribbling, and abdominal pain which had commenced shortly after discharge from the hospital. Careful questioning revealed a story of difficulty when voiding for many months. Micturition had never been forceful and when attempted it precipitated bouts of fretting and crying. The bladder was palpable up to the umbilicus. A catheter when passed met an obstruction near the urethrovaginal junction.

A subcutaneous urogram demonstrated slight dilatation of the right kidney pelvis and ureter

and definite caliectasis, pyelectasis, and ureterectasis on the left. No dye was visible in the greatly distended bladder. A one hour film following catheterization and removal of 150 cc. of urine showed a definite decrease in the dilatation of the kidney pelvis. The bladder showed a bizarre pattern, partially due to collapse following removal of the large quantity of urine, spasm from inflammation and infection, a filling defect in the trigone area, and tumor infiltration of the walls (Fig. 4, *A* and *B*). On cystoscopy, a smooth, glistening, polypoid-like tumor was seen arising from the base. A cystogram demonstrated a filling defect at the same site (Fig. 5). A few bacteria and white blood cells were found in the urine. The white blood cell count was 13,600, the red blood cell count 4,490,000, the blood urea nitrogen 9 mg. Penicillin therapy was commenced and continued throughout the hospital stay.

A suprapubic cystotomy was performed and a soft yellow polypoid tumor with a broad base was excised. The base was fulgurated. Biopsy of the remaining bladder wall was performed, though it appeared normal except for some moderate thickening.

Pathological report: The sections showed a solid tumor mass consisting of closely packed neoplastic cells with little cytoplasm, large rounded or oval nuclei, and distinct nucleoli. There were numerous mitotic figures. No differentiation of any sort was seen, and there was no distinct connective tissue framework. Several areas showed a myxomatous background. Tissue from the bladder wall and fundus showed the same neoplastic cells. Diagnosis: Myxosarcoma.

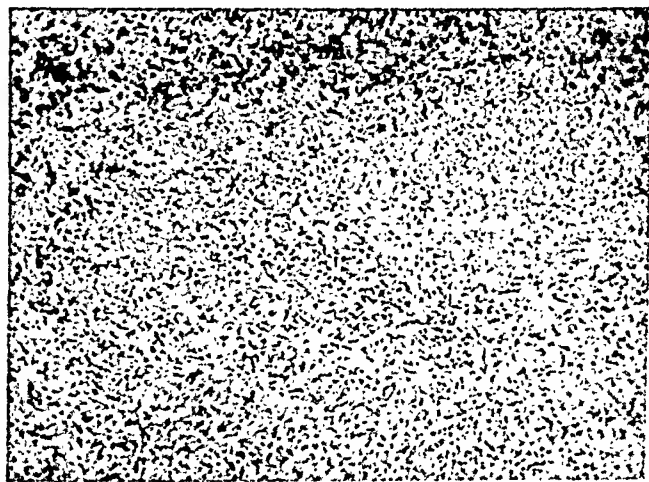


FIG. 3. Case I. Photomicrograph, 100X. Myxosarcoma.

Roentgen therapy: A series of fifteen treatments was given through a 10 by 10 cm. portal over the bladder area using 200 kv., peak, 0.5 mm. copper and 1.0 mm. aluminum filter, 50 cm. distance, and 20 ma. A total of 880 r, measured in air, was given anteriorly and a similar amount posteriorly. The patient was discharged clinically well August 8, 1947.

Incontinence suddenly reappeared September 18, 1947, following a month and a half

Christmas for a cystectomy. Roentgen irradiation, 720 r, was given through an anterior portal in fractional doses. Therapy was stopped the day before the following operation.

On December 28, 1947, the patient returned to the hospital. Urinalysis showed red and white blood cells and bacteria. The temperature ranged from 100 to 102°F. daily. Antibiotics were again given, and on January 5, 1948, exploration demonstrated no visible or palpable



FIG. 4. Case II. Intravenous urogram. (A) Caliectasis and pyelectasis, especially on the left. Bladder greatly distended. (B) A one hour film exposed after catheterization. The bladder presents a bizarre appearance due to collapse, neoplastic infiltration of the walls, and a filling defect at the base due to the tumor.

asymptomatic period. A recurrence was demonstrated by cystoscopic examination. At suprapubic cystotomy a nodular mass of myxomatous tissue was removed from the trigonal area. The base was fulgurated and thirteen radon seeds were implanted. The pathological report was similar to the previous description.

The patient was asymptomatic again for two months, after which time crampy abdominal pains recurred. Cystoscopy again showed a recurrence about the vesical orifice. The patient's symptoms were alleviated with sulfadiazine and streptomycin therapy, and he was discharged with instructions to return after

tumor extension beyond the bladder. The right ureter was transplanted to the proximal portion of the rectum and the left to the distal portion of the sigmoid. Ureteral catheters were passed from the ureters out through a mushroom rectal tube. The postoperative course was stormy, and the patient's condition remained critical for a two week period. Intravenous administrations of plasma, blood, glucose and saline solution, plus streptomycin and sulfadiazine eventually controlled the infection, the chemical balance was re-established, and the anemia and hypoproteinemia were corrected. On February 6, 1948, a month following the



FIG. 5. Case II. Cystogram demonstrating the filling defect in the trigonal area.

ureteral transplantation, a total cystectomy was performed. This included the bladder, prostate, proximal urethra, and adjacent available tissues. The postoperative course was relatively quiet, compared to the previous operation, and recovery was rapid. A follow-up blood examination showed the urea nitrogen to be 15 mg., the uric acid 1.0 mg., and the blood protein, chlorides, carbon dioxide capacity, and blood counts were well within normal limits. The patient appeared to be well developed and clinically a healthy child two months following the cystectomy. A urogram at this time demonstrated caliectasis and pylectasis on the right and an essentially normal picture on the left.

Pathological examination of the bladder specimen showed no infiltration of the tumor

cells into the prostate or to the other borders of the specimen. Apparently the lesion had been removed in toto. The tumor was firm, white, and uniform on cut sections. The original tumor was soft and myxomatous. The bladder wall in the specimen was obviously thickened throughout. Microscopic sections again showed dense infiltrations of tumor, cellular elements, largely in the submucosa layer. The cells were similar to those previously described, plus groups of oval, large, fascicular nuclei contained within a single elongated mass of cytoplasm. These latter formations of cells were undoubtedly myoid in origin. Diagnosis: Rhabdomyomyxosarcoma (Fig. 6, *A* and *B*).

Two and one half months following cystectomy a mass appeared in the left inguinal area and on bimanual palpation a lemon-sized suprapubic mass could be felt. These undoubtedly represented local recurrences in the regional lymph nodes. A roentgen survey of the long bones and chest was negative. Roentgen therapy is being given to these lesions, and they have all but disappeared with the course half completed. A depth dose of 3,500 to 4,000 r is to be given if tolerated by the patient. The prognosis is hopeless, but since there are no known distant metastases, a full course of roentgen therapy is planned.

Comment. Case I was obviously treated in an unsatisfactory manner. The family would not accept the diagnosis of a malignant tumor in so young an infant and they would not permit therapy of any type.

Case II, I believe, had excellent treatment except for two shortcomings. First

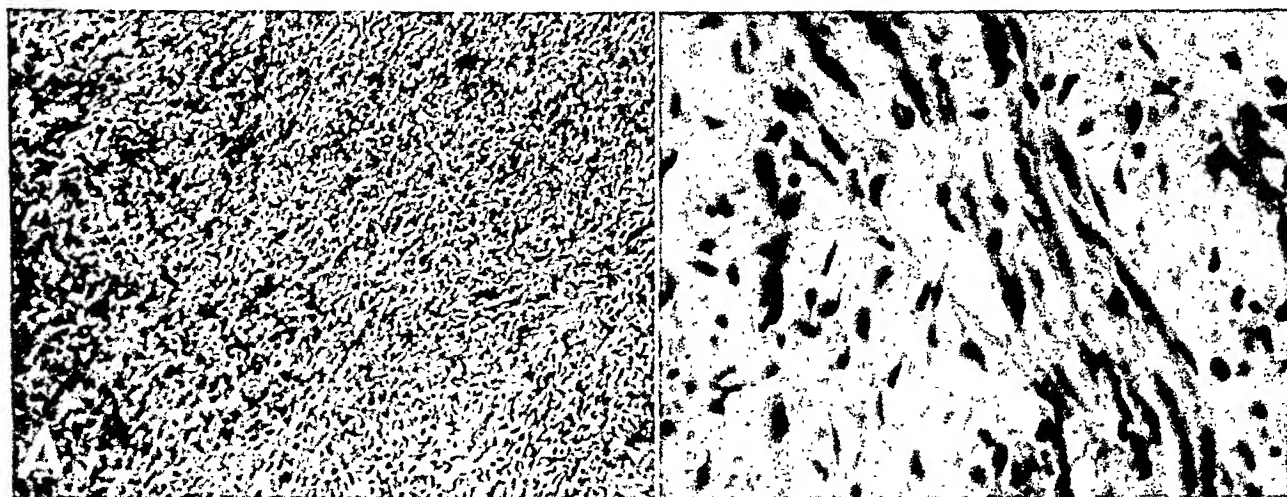


FIG. 6. Case II. (*A*) Photomicrograph, 100X. Rhabdomyomyxosarcoma. (*B*) 440X, showing the striated muscle cellular elements.

the amount of roentgen therapy was not large enough. Second, and more important, the ureteral transplantation and cystectomy should have followed the first course of radiation therapy. The diagnosis was established, the patient's condition was excellent, infection was controlled, and the kidney function was normal. Waiting was of no avail, except to prove, as do the cases in the literature, that these sarcomas recur following either excision, fulguration, radon seed implantation, and roentgen treatment, or a combination of these. In retrospect, all concerned with the patient feel this to be true. A cure might have been obtained had the cystectomy been done early. Though roentgen therapy is being given, complete destruction of the rhabdomyosarcoma is hardly expected.

SUMMARY

Eighty-nine cases of sarcoma of the bladder in children under the age of ten were found in the literature. Two more cases are added. Sixty-five per cent were located in the trigone. Seventy-five per cent occurred in children five years old or under, and they were three times as common in males as in females.

Metastases occurred late and rarely. Local invasion and spread were rapid. Early symptoms were for the most part similar to those of genitourinary tract infection. Hematuria may occur early or late as does urethral and ureteral obstruction. Cystographic and urographic roentgen studies and cystoscopy demonstrated the presence of the neoplasms. Biopsy was necessary for exclusion of the occasionally found benign tumor.

The prognosis was grave; death usually occurred within six months. The mortality rate was 93 per cent with only one report of a five year survival without residual tumor.

Surgical extirpation appeared to stimulate the sarcomas and resulted in invariable and rapid recurrences, except for the less common lesions located and limited to the fundus.

Antibiotics, bladder drainage, and deep roentgen therapy are indicated as the first treatment of choice for the neoplasms located in or near the trigone. The great majority of these sarcomas are moderately radiosensitive and can be expected to show an appreciable response. Complete destruction of these tumors will not occur. If renal function is then found to be satisfactory, cystectomy should follow with ureteral transplantation and a second course of radiotherapy two to four months later.

Bryn Mawr Hospital
Bryn Mawr, Pennsylvania

REFERENCES

1. BUGBEE, H. G., and DARGEON, H. W. Sarcoma of the bladder in an infant. *J. Pediat.*, 1941, 19, 656-661.
2. BUSER, H. Beitrag zur Kenntnis der Rhabdomyosarkome der Harnblase. *Schweiz. Ztschr. f. Path. u. Bakt.*, 1943, 6, 278-297.
3. CAMPBELL, M. F. *Pediatric Urology*. Vol. II. Macmillan Co., New York, 1937, pp. 300-302.
4. CECIL, H. L. Sarcoma of the bladder. *J. Urol.*, 1926, 16, 471-495.
5. CRANE, A. R., and TREMBLAY, R. G. Primary osteogenic sarcoma of bladder; complete review of sarcomata of the bladder. *Ann. Surg.*, 1943, 118, 887-908.
6. DEMING, C. L. Primary bladder tumors in the first decade of life. *Surg., Gynec. & Obst.*, 1924, 39, 432-442.
7. DESCHAMPS. Cited by Deming.⁶
8. DRAPER, J. W., and SICELUFF, J. G. Excretory cysto-urethrograms. *J. Urol.*, 1945, 53, 539-544.
9. EWING, J. *Neoplastic Diseases*. Fourth edition. W. B. Saunders Co., Philadelphia, 1940, pp. 943-944.
10. FEGGETTER, G. Y. Sarcoma of the bladder. *Brit. J. Surg.*, 1937, 25, 382-387.
11. HESS, E. Sarcoma of prostate and adjacent retrovesical structures. *J. Urol.*, 1938, 40, 629-640.
12. HESS, E. Personal communication, December, 1947.
13. HIRSCH, E. F., and GASSER, G. W. Extramural rhabdomyosarcoma of the neck of the urinary bladder. *J. Urol.*, 1944, 51, 517-519.
14. KHOURY, E. N., and SPEER, F. D. Rhabdomyosarcoma of the urinary bladder. *J. Urol.*, 1944, 51, 505-516.
15. KIKUTI, T., and KINAKAWA, Y. Case of sarcoma of ovary appeared in a girl. *Jap. J. Obst. & Gynec.*, 1940, 23, 299-300.
16. KLEIN. Cited by Deming.⁶

17. McCARTHY, J. F., STEPITA, C. T., and HALPERIN, S. J. Sarcoma of the bladder. *Am. J. Surg.*, 1929, 7, 229-233.
18. MEADE, H. Myxomatous tumour of the bladder simulating a stone in the bladder, in a child aged 5 years. *Brit. J. Urol.*, 1943, 15, 10-11.
19. MINTZ, E. R. Sarcoma of bladder in children. *New England J. Med.*, 1931, 205, 756-759.
20. MIXTER. Cited by Crane and Tremblay.⁵
21. MONTENEGRO, A. Tumor maligno de vejiga en un niño de tres años. *Rev. de especialid.*, 1929, 4, 1085-1087.
22. RAAP, G. Sarcoma of the prostatic area in an infant aged four months. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 185-188.
23. RATLIFF, R. K., and VALK, W. L. Sarcoma of bladder. *J. Urol.*, 1939, 42, 559-565.
24. RITTER, J. S., and KRAMER, S. E. Carcinoma of the bladder (total cystectomy). *Urol. & Cutan. Rev.*, 1945, 49, 532-534.
25. TAHARA, C., BURT, K. L., and HESS, E. Sarcoma of the bladder. *Urol. & Cutan. Rev.*, 1945, 49, 534-538.
26. UHLMANN, E., GROSSMAN, A., and CALVIN, J. K. Rhabdomyosarcoma of the urinary bladder. *Ann. Surg.*, 1939, 109, 624-631.
27. VERMOOTEN, V. Rhabdomyomysosarcoma of the bladder. *J. Urol.*, 1939, 42, 126-130.
28. WELFELD, J., HILL, L., and HILLEBRAND, J. G. Rhabdomyomysosarcoma of the urinary bladder. *J. Urol.*, 1936, 36, 150-156.
29. WEYERBACHER, A. F., and BALCH, J. F. Leiomyosarcoma of the bladder. *J. Urol.*, 1937, 38, 278-287.
30. WHEELOCK, M. C. Sarcoma of urinary bladder. *J. Urol.*, 1942, 48, 628-634.



PARTLY DUPLICATED COLON*

CASE REPORT

By BELA GONDOS, M.D.

WASHINGTON, D.C.

IN THE literature only a few cases of duplicated colons have been recorded. Weber and Dixon reported a case of an entire duplication, where the supernumerary colon reaching from the cecum to the rectum was situated parallel to the normal one. They both had a common mesocolon. There was no communication between the normal colon and the duplicated one; the latter was closed at both ends. Diagnosis was made by roentgen examination. The duplicatum appeared as a slight shadow. When examined with barium enema, many impressions caused by the duplicatum were visible on the normal colon. There was also found a duplication of the uterus. Another case was reported by Duhem and Monmignault, in which a girl, three years of age, had two transverse and descending colons, two rectums and two (functioning) anal canals. In this case also there was a duplication of the genital organs. Duplication of the colon was also reported by Asai, Ballance, Grohé, Ladd and Gross and Papayoannou. Gray reported a case of triplicated colon.

The following case is one of partial duplicated colon, running from the region of the hepatic flexure to the lower part of the descending colon. Proximally it ends blindly; the distal end communicates with the descending colon. A summary of the case history follows.

CASE REPORT

The patient was a girl, aged ten. Dull pains occurred in the right side of the abdomen. Spontaneous bowel movements only every third day. On the right side of the abdomen was a palpable mass, resembling a kidney in size and shape. This mass followed the respiratory movements and was easily moved with the hand. In another institution a roentgen ex-

amination was made, first with a barium enema and later with a "plain kidney film." This showed in the upper part of the right half of the abdomen a shadow identical with the palpated mass in size and shape. The shadow was calcium-like in density and granular in composition. In the opinion of this institution this shadow was probably caused by an extensive calcification of the right kidney.

The girl was then directed to our institution. We made a roentgenoscopic examination and afterwards a roentgenogram of the right kidney region (the latter in horizontal position (Fig. 1)). A shadow was found conforming to that of the earlier examination. In addition, we found that proximally the shadow was surrounded by a gascoat. We thought therefore



FIG. 1. Kidney-like shadow in the right part of the abdomen. The film was made after a barium enema examination. Gascoat proximally in the sac-like structure.

* The author observed this case in the Roentgen-Ray Department (Medical Chief: Dr. R. Holitsch) of the "Apponyi Poliklinik" in Budapest and subsequently published it in part in *Gyógyászat* (a Hungarian medical journal).

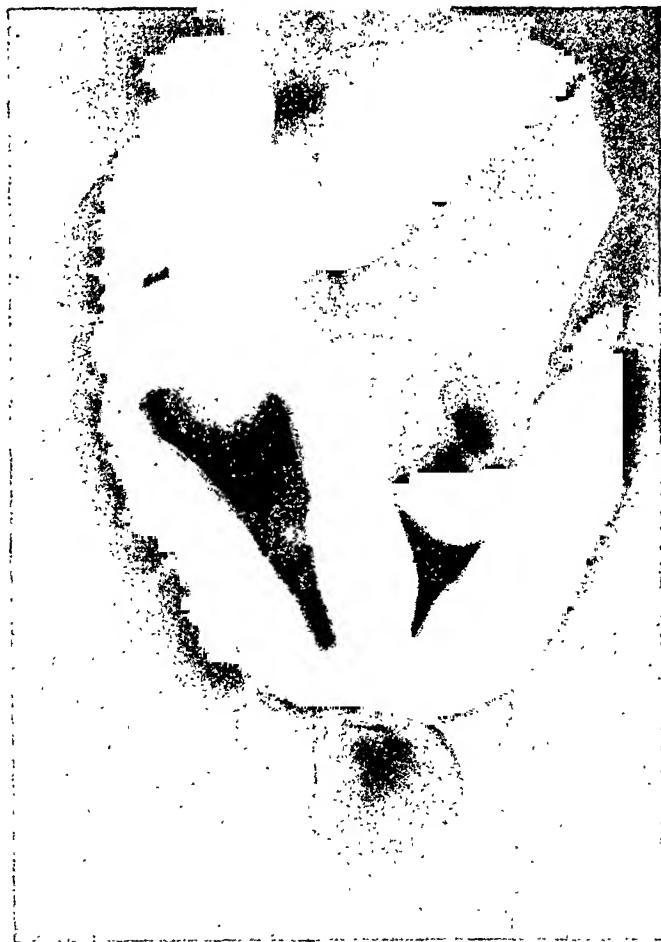


FIG. 2. Barium enema examination. There is no connection between the sac and the right part of the large intestine. A supernumerary colon runs to the descending colon.

that a sac-like structure was present connected with the gastrointestinal tract and that the shadow was caused by contrast material in the sac as a result of the barium enema examination. (The intestine-like structure running from the region of the under part of the shadow to the left part of the abdomen we thought then to be the normal transverse colon.) We had the patient take laxatives and purgatives many times in order to eliminate the contrast material. The picture, however, was unchanged, even after ten days. Then we performed a barium enema examination (Fig. 2). We could then establish the fact that the sac was not in connection with the proximal part of the colon. It was also obvious that the intestine-like structure, starting at the under part of the sac, was not identical with the transverse colon. This was shown to be in connection with the sac and identical with a supernumerary intestine, which was filled from the lower part of the descending colon and ran towards the right. It seemed probable that

a supernumerary large intestine existed connecting the sac with the descending colon. Also there was found a large sigmoid.

Later we made an examination of the gastrointestinal tract with peroral filling. In the stomach, duodenum and small intestine, no pathological condition was found. Examination of the large intestine (24 hours p. c.) strengthened our earlier opinion (Fig. 3). Our findings were as follows.

There was a sac-like structure in the right side of the abdomen, which was connected with the descending colon by a supernumerary intestine. The sac-like structure was filling and evacuating only through this supernumerary intestine. We concluded that the interpretation



FIG. 3. Peroral filling after twenty-four hours p. c. The same findings.

in the first examination at the other institution was a diagnostic error.

After six months the patient was operated on. Roentgen examination made just before the operation showed the same findings as the earlier ones. The operation confirmed our impression. There was found a sac-like structure connected with the colon. A resection was not attempted because of the great risk involved. After ten years another operation was done (by Prof. Bakay, Klinik of the Pázmány Péter-University, Budapest). The important operative findings follow:* "...One can isolate only with difficulty the sac having the size of a child's head, because of the cicatrization caused by the earlier operation. The

* For placing this record at my disposal, I am indebted to Dr. A. Gusich, Adjunct of the Klinik.

structure is pliable and keeps the finger impressions. It is lying retroperitoneally and is situated between the upper part of the kidney, the flexura coli dextra and the liver. The sac continues toward the left behind the mesentery in a band the width of two fingers, having the appearance of an intestine. This intestine opens into the upper part of the sigmoid. In the course of the dissection of the sac—grown together with the vena cava and other organs—great veins were broken causing great bleeding. Also the sac wall was broken; then appeared a fecal-like mass. The bleeding veins and the ruptured sac were tamponaded and the abdomen was left open. Peritonitis occurred, followed by death of the patient.

"From several parts of the sac excisions were made. Their microscopic examination showed a finding identical with that of the colon wall. The muscular layer was hypertrophied in some places." A developmental defect of the urogenital tract was not found.

On the basis of the microscopic examination the sac was that of an actual enlarged part of colon. I considered, therefore, the intestine starting from its under part and the sac as uniform structures and the sac itself as enlargement of this abnormal intestine. It exists a supernumerary colon as a developmental defect, which starts blindly at the region of the right flexure and opens into the descending colon. It is very probable that the enlargement developed secondarily. Golden reports that narrowings in the gastrointestinal tract occur as developmental defects. This kind of narrowing might exist in the opening of the sac, which caused difficult evacuation and therefore secondary enlargement. This narrowing was not proved anatomically (examination at the operation and section were not made from this point of view), but the great difficulty of evacuation indicates its presence. (The contrast material was not evacuated from the sac even after many months.)

Our case is substantially different from most of the cases reported because the supernumerary colon had its own mesocolon. Only Papayoannou reported an almost identical case. This was a girl, who had an immense tube-like structure connected with the colon. The whole structure was situated in an umbilical hernia. A bicarnate uterus was also found. I interpret

Papayoannou's case in the same way as I do my own. In both cases there existed a supernumerary colon as a developmental defect, which secondarily partly enlarged. The fact that our patient had not also a development defect in the urogenital apparatus does not contradict this interpretation. The supernumerary colon opens into the descending colon so high that this part could not have a relation with the urogenital apparatus in the embryonic stage of the development.

SUMMARY

A girl, aged ten, had a sac-like structure the size of a child's head in the right part of the abdomen. Proximally this structure was closed; distally it continued as a supernumerary colon, which communicated with the distal part of the descending colon. This sac is considered to be an enlargement of the supernumerary colon.

1720 Connecticut Ave., N.W.
Washington 9, D. C.

REFERENCES

1. ASAI, T. Duplication totale du gros intestin. *Arch. f. jap. Chir.*, 1933, 10, 292-593.
2. BALLANCE, HAMILTON. Double colon. *Proc. Roy. Soc. Med.*, 1930, 23, 1570-1572.
3. DUHEM, P., and MONMIGNAULT. Sur un cas de côlon double avec double anus et organes génitaux doubles. *Bull. et mém. Soc. de radiol. méd. de France*, 1936, 24, 821.
4. GOLDEN, R. Radiologic Examination of the Small Intestine. J. B. Lippincott Co., Philadelphia, 1945.
5. GONDOS, B. Rare case of colonic diverticulum. *Gyógyászat*, 1932, 72, 275-276.
6. GRAWITZ, P. *Virchow's Arch. f. path. Anat.*, 68, 500.
7. GRAY, A. W. Triplication of the large intestine. *Arch. Path.*, 1940, 30, 1215-1222.
8. GROHÉ, B. Duplicatas intestini crassi cum utero et vagina dupl. (ihre entwicklungsgeschichtliche Deutung und operative Correctur). *Deutsche Ztschr. f. Chir.*, 1900, 57, 445-467.
9. LADD, W. E., and GROSS, R. E. Surgical treatment of duplications of the alimentary tract. *Surg., Gynec., & Obst.*, 1940, 70, 295-307.
10. PAPAYOANNOU. *J. de Chir.*, 1928, 32, 106.
11. WEBER, H. M., and DIXON, C. F. Duplication of the entire large intestine (colon duplex). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 55, 319-324.

THE ROLES OF SURGERY AND RADIOLOGY IN THE TREATMENT OF CANCER*

By L. HENRY GARLAND, M.D.

SAN FRANCISCO, CALIFORNIA

"Physicians are some of them so pleasing and conformable to the humour of the patient, as they press not the true cure of the disease; and some are so regular in proceeding according to art for the disease, they respect not sufficiently the condition of the patient." Of Regiment of Health. Francis Bacon, 1597.

INTRODUCTION

THE paradox of cancer remains that although our knowledge concerning the disease is steadily increasing, so are the number of cases, owing apparently to the fact that we are an aging population. No radiologist needs to be reminded of the fact that it is now the second most common cause of death in this country and that it ranks high as a source of morbidity. Although the general mortality trend is upwards, the specific mortality rate for certain types of cancer (such as those of the lip, cervix uteri, etc.) has taken an encouraging downward curve in the last decade, reflecting the results obtainable with more efficient or earlier treatment.⁷

The fact that the exact cause of cancer is still unknown tends to produce unwarranted pessimism on the part of many. In this connection it must be recollected that mere discovery of causation would not necessarily result in any precipitous or extraordinary improvement. The causes of tuberculosis and typhoid were discovered over fifty years ago, yet the cure of established cases of these two diseases still remains difficult. Their prevention is simplified, but their cure is still intricate. Similarly, when and if all of the causative agencies of cancer are found, it is anticipated that prevention—the real goal of medicine—rather than cure of established cases, will be greatly enhanced. In the meantime our main hope lies in early diag-

nosis, and prompt, adequate treatment.

Our principal weapons for the cure and palliation of cancer remain surgery and irradiation; subsidiary but sometimes important agents are chemotherapy, hemotherapy and miscellaneous medical procedures. The optimum method of treatment is often difficult to determine from reports in the literature, partly because of lack of uniformity in clinical staging of cases, and partly because of different methods of evaluating results.

It is not always of prime importance which of two given methods is used in an individual case: the essential thing is that the treatment be *adequate*. Sometimes this is effected equally well by surgery or irradiation; in others it requires a combination of both techniques and in still others surgery alone or irradiation alone is superior. Experience has taught us much of how and when to use these techniques. Today, I propose to review this experience and, in passing, to stress the advancing front of radiology. In doing so I would like to pay tribute to the distinguished surgeons, gynecologists and dermatologists who have played so great a part in blazing these therapeutic trails, and to the physicists, without whose help radiation therapy would be still empiric.

CURE VS. PALLIATION

Having established the diagnosis of malignant disease—not always a simple process, and one usually requiring the services of a skilled tissue pathologist†—the problem facing the physician is the selection of the best type of treatment—sometimes

† In this connection it is of interest to note that biopsy is only about one hundred years old (Donaldson, F. *Am. J. M. Sc.*, 1853), while practical radiation therapy is perhaps fifty years of age.

* From the Department of Radiology, Stanford University School of Medicine, San Francisco, California, San Francisco Hospital Service. Presented at the Thirty-first Annual Meeting, American Radium Society, Atlantic City, N. J., June 5-7, 1949.

defined as the one with least physical, psychic and economic trauma. The primary decision must be whether treatment should be radical (to cure), palliative (to alleviate) or merely supportive (to render an advanced process less intolerable).

If cure appears reasonably possible, then shall it be by means of surgery, irradiation or a combination of the two methods? That surgery can cure cancer is accepted by all: that radiology does likewise is still questioned by some. The reasons for this are multiple—psychologic, pedagogic and hereditary! However, for those who will pause to review the numerous microscopically proved ten and twenty year cures achieved by the irradiation method there is no ground for doubt. An adequate dose of ionizing radiation will cure a squamous cell cancer of reasonable proportions, if delivered with proper technique in a specified period of time, just as surely as radical excision or other annihilative methods.^{1,5,6}

CHOICE OF METHODS

The choice of surgery or irradiation as the primary method of treatment depends on many factors such as the type and location of the tumor, the condition of the patient, the availability of a competent surgeon or radiologist, and so forth. The type and location of the tumor is of considerable importance and may settle the question alone. For example, a squamous cell carcinoma, well differentiated and of reasonable size, which arises in the rectum of a patient in good general condition, is a purely surgical problem. A small squamous cell cancer of the eyelid is a radiological problem (i.e. best treated by irradiation). A localized cancer of the anterior third of the tongue may be well treated by either method.

Since surgery is the method that has long established itself, one may reasonably ask why and when is radiation therapy preferable? We believe that irradiation is preferable in the treatment of *suitable lesions* for the following reasons:

1. Better cosmetic results (e.g., in cancer

of the skin of the face, especially about the eyes, etc.)

2. Better functional results (e.g., in cancer of the lip, tongue, larynx, etc.)

3. Better clinical results (e.g. in cancer of the cervix uteri, in Hodgkin's disease, lymphosarcoma, medulloblastoma, etc.)

4. Less physical strain on patients in poor general condition (cancer of fundus in a hypertensive, etc.)

5. Less economic strain (hospitalization usually not necessary, etc.)*

6. Less psychic strain (in persons with chirurgophobia, etc.).

The advantages of surgery are too well known to need repetition here; the types of cases which we regard as best suited for surgery are outlined in the following pages.

What of the disadvantages of either method? The first and most serious disadvantage is that complete removal or eradication of the tumor may at times not be achievable, despite initially favorable conditions. The next is a series of well known surgical and radiological complications. Necrosis of the ureters may follow a Wertheim operation, or fibrosis a course of pelvic irradiation. Serious hemorrhage may follow a glossectomy or heavy glossal irradiation. The early and late complications of surgery seem to be less stressed than those of irradiation—for reasons concerning which we as radiologists must be philosophical. However, those of irradiation are not negligible and require constant vigilance for reduction and possible prevention. Radiation ulcers; radiation osteonecrosis and chondronecrosis cannot, unfortunately, always be avoided, if one is to achieve cure of the malignancy. The prolonged time sometimes required for cure by irradiation; the painful nature of some radiation reactions, and the atrophic skin changes ulti-

* That a majority of roentgen-ray and many radium therapeutic procedures can be performed efficiently in a properly equipped office is known to all radiologists, but only to a minority of recent graduates—due perhaps to the prolonged institutionalization involved in modern medical training. That radiologists ever *treat* cases is known only to a minority of the public. The relative convenience and economy of ambulatory care for cancer patients is not an idle consideration and needs emphasis to graduates and "planners" alike.

TABLE I

SURGICAL THERAPY USUALLY INDICATED
(Treatment of Choice)

Accessible Sites:
1. Breast (Stage I)
2. Metastatic cervical nodes
3. Corpus uteri (operable)
4. Salivary glands
5. Thyroid
Inaccessible Sites: (Tumor Operable)
1. Brain and spinal cord
2. Esophagus and stomach
3. Small intestine
4. Colon and rectum
5. Kidney
6. Bladder
7. Prostate
8. Lung, etc.

TABLE II

RADIATION THERAPY USEFUL ADJUNCT
TO SURGERY

1. Breast (Stage II), postoperative
2. Thyroid, postoperative
3. Uterus, corpus, preoperative
4. Ovary, postoperative
5. Testis, postoperative
6. Bladder
7. Kidney (bulky adenocarcinoma and Wilms' tumor)
8. Miscellaneous tumors, including postoperative recurrence, incomplete removal, etc. (e.g. breast, brain, skin, etc.)

mately present in some cases are other disadvantages. The first is difficult to avoid; the other two are being gradually obviated in most cases.

As a general guide to the use of one or the other method I would like to offer the following series of four tables. They are based on a personal experience of some twenty years in clinical radiology, plus the knowledge of results obtained by other physicians and surgeons. Incidentally, they represent the policy of the Tumor Board on the Stanford University Service at San Francisco Hospital. The tables are designed to indicate the types of tumor best suited at the present time for

Table I. Surgical therapy

Table II. A combination of surgical and radiation therapy

Table III. Radiation therapy alone, and

Table IV. Tumors for which radiation therapy is rarely or never recommended.

It is to be remembered at all times that *in individual cases, circumstances may require departure from this general plan.* However, we believe that the arrangement is a practical and useful one, and of value in maintaining consistency in one's therapeutic approach.

RESULTS OBTAINABLE

The results obtainable by judicious radical surgery and irradiation are well known. Nevertheless a few examples may be of

TABLE III

RADIATION THERAPY USUALLY INDICATED
(Treatment of Choice)

Accessible Sites:
1. Skin
2. Lip and mouth, including tongue
3. Breast (Stage III)
4. Cervix uteri
5. Anal and urethral orifices
Inaccessible Sites:
1. Embryonal tumors—kidneys, testis, ovary
2. Endotheliomas—Ewing's, etc.
3. Medulloblastoma
4. Cancer of the larynx and nasopharynx—selected cases
5. Cancer inoperable, e.g. lung, esophagus, etc.
6. Cancer metastatic, esp. in bone, skin, etc.
7. Lymphoblastoma (Hodgkin's disease and lymphosarcoma) and leukemia

TABLE IV

RADIATION THERAPY RARELY OR
NEVER INDICATED

1. Osteogenic sarcoma
2. Miscellaneous "adult" sarcomas
3. Cancer of the intestines
4. Cancer of the gallbladder
5. Cancer of the liver
6. Cancer of the pancreas
7. Advanced cancer with cachexia
8. Acute leukemia
9. Melanoma

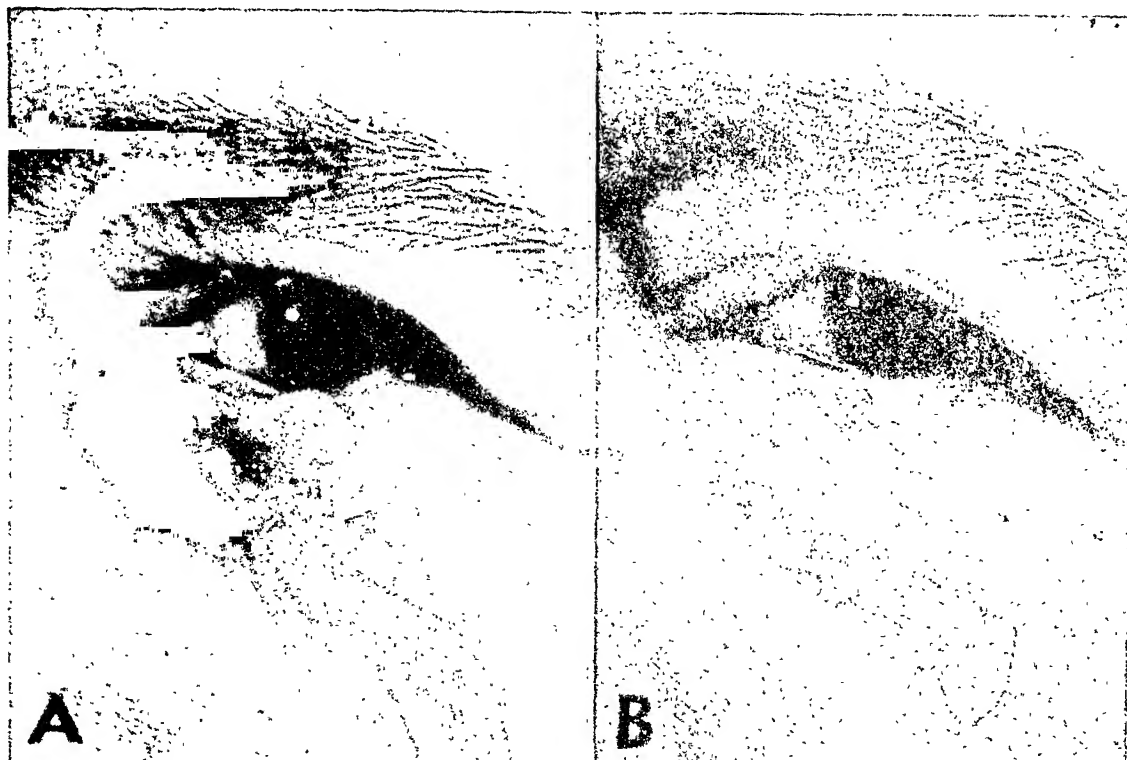


FIG. 1. Case I. Carcinoma of the lower lid. Clinical cure over eleven years.
Case before (A) and five years after treatment (B).

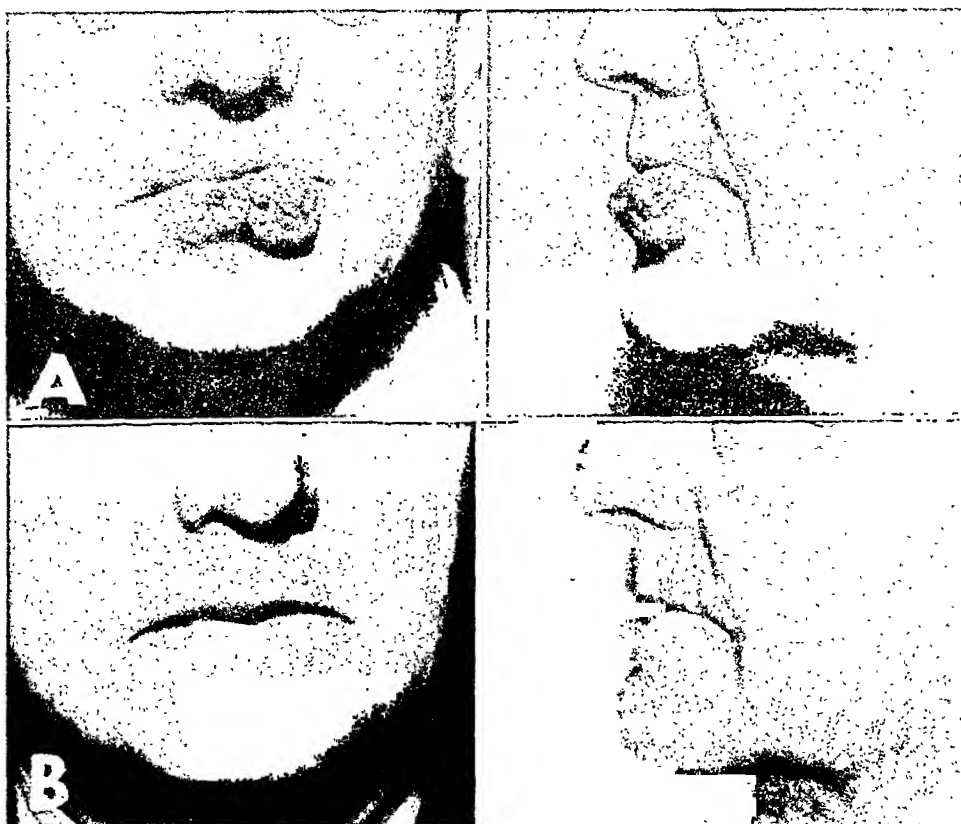


FIG. 2. Case II. Carcinoma of the lip. Clinical cure for nine years.
Case before (A) and five years after treatment (B).

value in illustrating the great benefits of irradiation in some commonly encountered lesions, if only to emphasize the selective place of irradiation.

CASE I. Carcinoma of the lower lid. Male, aged fifty-eight, squamous cell carcinoma, biopsy proved. Treatment: Roentgen irradiation. Tumor dose 6,000 r in fifteen days, to a field 2.5 cm. in diameter (half-value layer 0.3 mm. Cu). Clinical cure over eleven years.

CASE II. Carcinoma of the lip. Male, aged sixty, with squamous cell carcinoma, Grade 3,

CASE IV. Carcinoma of the lung. Male, aged fifty-eight, with biopsy verified inoperable bronchogenic carcinoma. Treatment: Roentgen irradiation. Tumor dose approximately 4,000 r in six weeks (half-value layer 1.9 mm. Cu); fields 20 by 15 cm. Relief of cough and hemoptysis: survived two years. Death from cerebral metastases.

CASE V. Hodgkin's disease of the stomach. Male, aged thirty-eight, with known Hodgkin's disease for four years (cervical node biopsy). Ulcerating gastric tumor found following

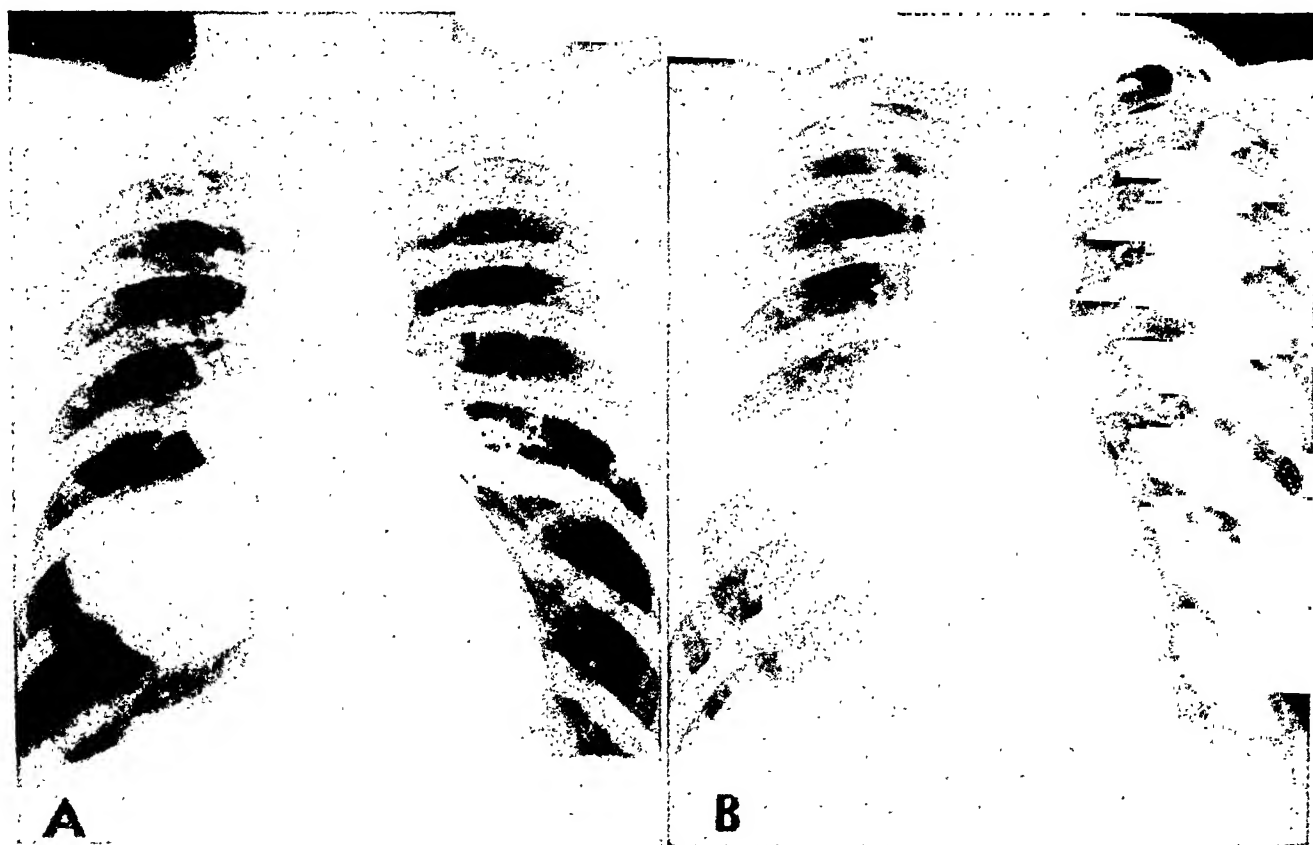


FIG. 3. Case IV. Carcinoma of the lung. Relief of cough and hemoptysis; survived two years. Death from cerebral metastases. Case before (A) and one year after treatment (B).

invading muscle (biopsy proved). Treatment: Roentgen irradiation. Tumor dose 5,000 r in twenty-five days (half-value layer 1.0 mm. Cu) to a field 6 cm. in diameter. Clinical cure nine years.

CASE III. Carcinoma of the larynx. Male, aged fifty-five, with epidermoid cancer, left vocal cord (biopsy proved). Treatment: Roentgen irradiation. Tumor dose 5,500 r in five weeks (half-value layer 1.0 mm. Cu) to a field gradually reduced from 8 to 5 cm. in diameter. Cured ten years.

massive oral and rectal hemorrhage (Hgb. 20 per cent; erythrocytes 1.25 million). Treatment: bed rest and roentgen irradiation. Only a low voltage unit was available in his community (half-value layer 0.3 mm. Cu): given 1,000 r to a large epigastric field in three weeks. Lesion reduced in five weeks and not demonstrable in twelve weeks. Patient also had pulmonary and sacral lesions which required subsequent roentgen treatment. Survived nine more years.

CASE VI. Lymphosarcoma of neck, skull and femur. Male, aged thirty-seven, with lympho-



FIG. 4. Case v. Ulcerating gastric Hodgkin's disease, before, during and after roentgen treatment. Tumor dose approximately 500 r in three weeks. Lesion in stomach remained arrested for nine years. Lesions in cervical nodes, lungs and bones also required treatment. Multiple biopsy verification.

sarcoma (cervical node biopsy); severe frontal headaches and pain in left hip for one year. Given "total body" irradiation: 600 r in air, to each side of head, 600 r to entire pelvis and femora, front and back, and 300 r to entire neck and shoulders laterally. Half-value layer 1.0 mm. Cu, 80 cm. distance, fields 40 cm. in diameter. Treatment time only ten days! Gradually improved and returned to work. Roentgen examination one year later showed no lesions. After six years developed left pulmonary and thyroid masses. Given 230 r in air, anterior and posterior, to torso in ten days. Died two years later. Necropsy showed lymphoblastoma, type bizarre (Budd). Survived eight years.

CASE VII. Myeloma, plasma cell type, of femur. Female, aged fifty-one, with spontaneous fracture left femur: biopsy of rib showed myeloma. Treatment: splint and roentgen irradiation. Tumor dose 1,000 r in six days (half-value layer 1.0 mm. Cu). Fracture healed. Survived four years and died with meningitis.

In the following tables (v, vi and vii)

there are summarized the results obtainable with modern radiation therapy in the hands of such experienced radiologists as Paterson of Manchester, and Hamann of Chicago.

TABLE V
FIVE YEAR RESULTS OF RADIATION TREATMENT IN 8,298 CASES

(Mx. proved cancer, miscl. sites, Holt Radium Institute, 1946)	
Early cases only (one-third of the total)	86% survival
Late cases only (less than one-half of the total)	13% survival
All cases treated: total percentage alive	40%

In connection with Table VII it is realized that a significant number of the favorable results, especially the five year survivals in these particular diseases, is not necessarily due to radiation therapy. Some cases of leukemia and malignant lymphoma will survive for five years without treatment of any type; such persons have a

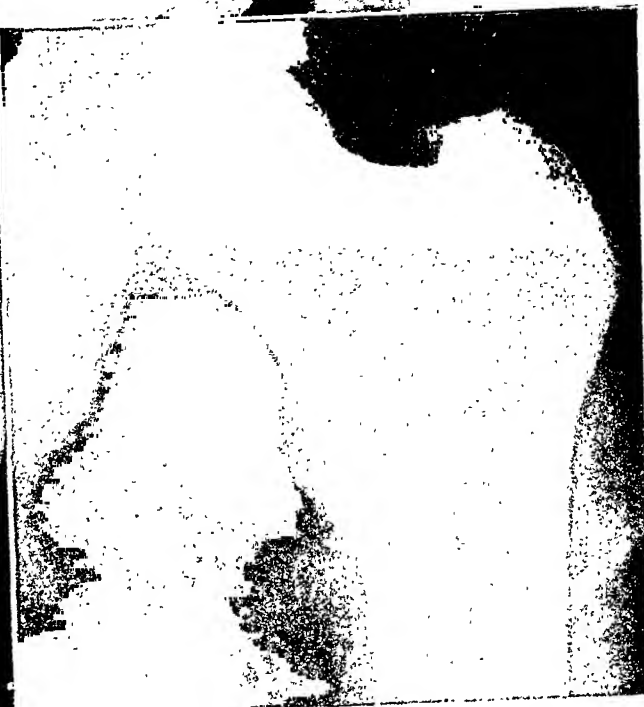
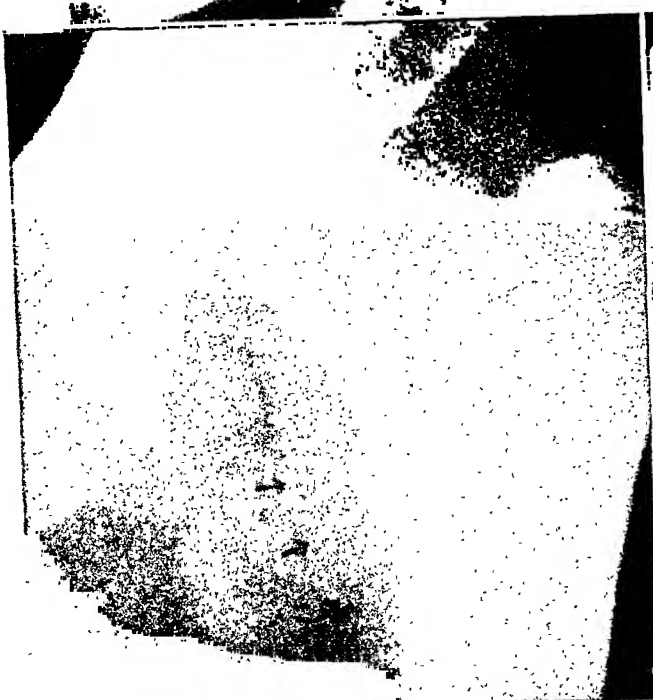
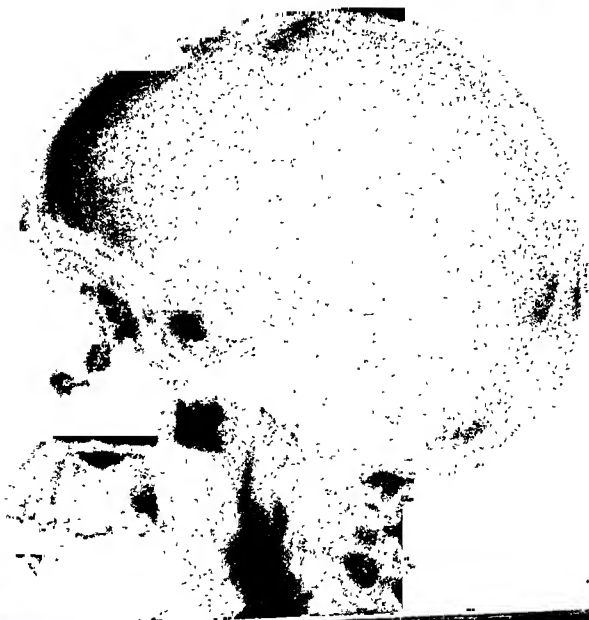
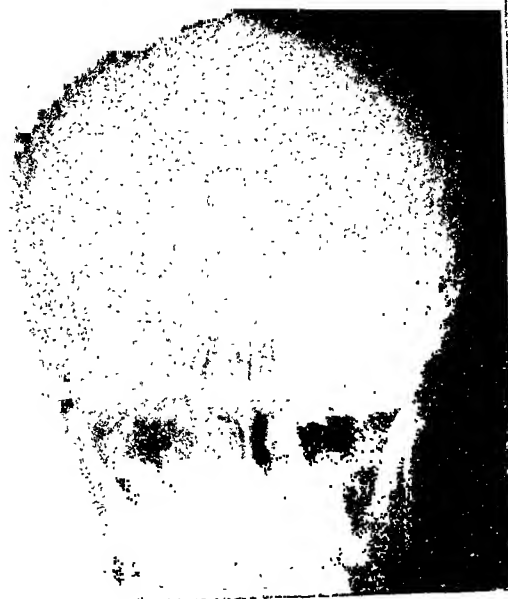


TABLE VI
FIVE YEAR SURVIVALS FOLLOWING RADIATION THERAPY, BY SITES (HOLT RADIUM INSTITUTE)

Cancer of the skin	1803 cases	88%	(98% of 1236 early cases)
Cancer of the breast including post-operative recurrence	863 cases	20%	(55% of 69 early cases)
Cancer of the uterus and cervix	826 cases	28%	(65% of 48 early cases)
Cancer of the lip and mouth	1289 cases	30%	(64% of 300 early cases)
Cancer of the uterus corpus	91 cases	26%	(71% of selected early cases)

relatively mild and chronic form of the disease. The exact percentage of these is difficult to ascertain, and is sufficiently small not to invalidate the statement that judicious irradiation with roentgen rays greatly increases the effective life and comfort of most patients, and prolongs the life of a few. Irradiation may be a life-saving procedure in patients with obstructive mediastinal and diffuse infiltrating renal lymphomas.

CURABLE CANCERS

In the foregoing paragraphs and tables we have referred to cancers as being of two general types, accessible and inaccessible. The former appear to be curable in a good percentage of cases; the latter are a source of less fruitful outcome. What are the apparent *facts* today as to the curability of cancer in general? We believe that the following data, compiled from many sources, give a clue as to the answer.

The incidence of cancer according to site in living persons in the United States is estimated to be approximately as follows.^{1,3,4} The figures pertain to the combined sexes, and for purposes of brevity we list only the ten most common sites:

1. Breast
2. Skin
3. Stomach
4. Uterus (cervix:corpus::4:1)
5. Colon
6. Rectum and rectosigmoid
7. Prostate
8. Bladder (and urinary system)

9. Lung (and respiratory system)
10. Lip (and buccal cavity)

The *mortality of cancer*, according to available statistics is as follows.^{4,10} (It is fully realized that the accuracy of mortality data is not of high order; nevertheless it is believed that the census reports and published autopsy figures give a guide to the general picture.) Mortality by sites

TABLE VII
RESULTS OF RADIATION THERAPY IN
LYMPHOMAS (HAMANN)
(Survival *after* beginning of roentgen therapy)

Type	Cases	3 yr.	5 yr.
Chronic myelogenous leukemia	49	33%	14%
Chronic lymphogenous leukemia	51	30%	23%
Hodgkin's disease	143	35%	21%
Lymphosarcoma	77	12%	9%

(Average survival in first three groups approximately 32 mo.) (*Radiology*, 1948, 50, 376)

in order of frequency—8 most common sites:

1. Stomach
2. Intestines (excluding rectum)
3. Breast
4. Uterus
5. Liver
6. Lung
7. Male genitals (including prostate)
8. Rectum

The *curability of cancer*. According to sources such as the Registry of Cases of

FIG. 5. Case VI. Lymphosarcoma of skull and left femur (lesser trochanter). Patient also had cervical node involvement (biopsy proved) and, presumably, other deep-seated lesions. He was therefore treated by roentgen irradiation to the skull and torso, including the femora, 600 r(air) to entire area in ten days (see text for details). Survived eight years, ultimately succumbing to his disease.

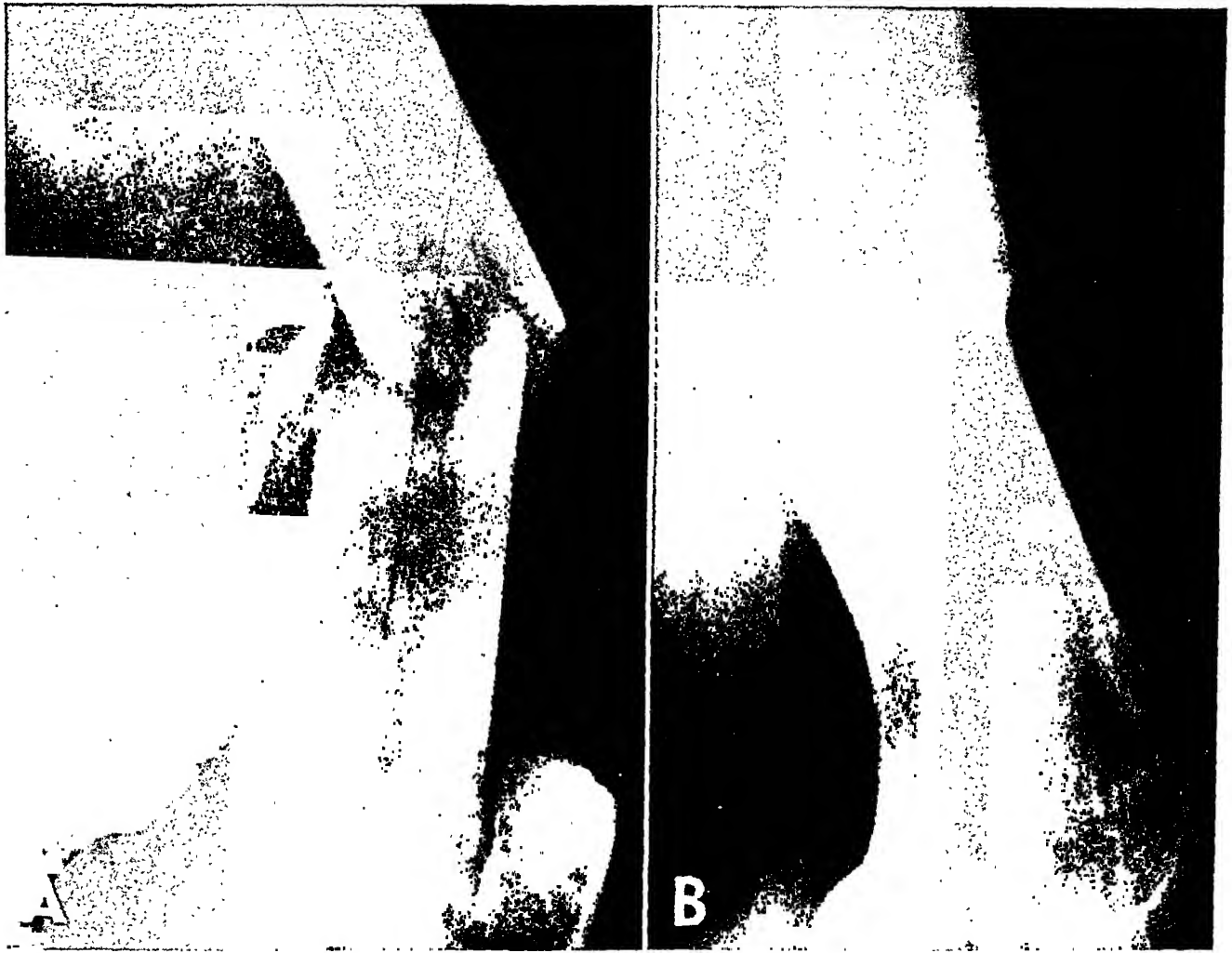


FIG. 6. Case VII. Plasma cell myeloma of femur, before (A) and after (B) roentgen treatment, showing healing of the pathological fracture. Tumor dose 1,000 r in six days. Survived four years. Death from independent causes. (Courtesy of *Radiology*.)

Cured Cancer of the American College of Surgeons, this is as follows.^{2,5,7} Six most often cured lesions:

- | | |
|--------------------|---------------------|
| 1. Breast | 4. Colon and rectum |
| 2. Uterus (cervix) | 5. Skin |
| 3. Lip and mouth | 6. Uterus (fundus) |

From these data, and from the experience of our own Tumor Service and practice during the last twenty years, we believe that the 6 most commonly encountered curable cancers are those of the

- | | |
|--------------------|---------------------|
| 1. Skin | 4. Colon and rectum |
| 2. Breast | 5. Lip and mouth |
| 3. Uterus (cervix) | 6. Uterus (fundus) |

INDICATED METHODS OF TREATMENT

With the realization that cure is possible in a high percentage of early cases of accessible cancer, what then are the facts as to the relative roles of surgery, irradiation

and other methods in the treatment of these cases? Making due allowance for the *stage* of disease often present when our patients first consult or reach us, we believe that the following is a fair estimate of the need and indications for the different methods of treatment in the six most often curable groups (Table VIII).

Table VIII indicates that radical or palliative surgery alone is indicated in about 33 per cent of the theoretical group of cases; radical or palliative irradiation in 43 per cent; surgery plus irradiation in 17 per cent; and no surgery or irradiation in about 7 per cent. Of the breast cases especially, a certain number, at least one-third, will need irradiation or other therapy for metastases developing some years after radical surgery.

Now, of course, no one surgeon, radi-

TABLE VIII

ESTIMATED PERCENTAGE OF CASES SUITABLE FOR INITIAL TREATMENT BY FOLLOWING METHODS:

Tumor ¹ Site	Radical Surgery Alone	Radical Surgery plus Irradiation	Radical Irradiation Alone ²	Palliative Surgery	Palliative Irradiation	Medical Only ³
Skin	25%	0%	65%	5%	5%	0%
Breast	40	30	10	5	5	10
Uterus (cervix)	5	0	60	5	25	5
Colon and rectum	60	0	0	30	0	10
Lip and mouth	15	20	55	0	5	5
Uterus (fundus)	10	50	20	0	10	10

¹ This table lists only the first six groups of commonly curable cancers.² Note that this column is high because skin, cervix and lip cases predominate.³ These are mostly very advanced cases, not offering much hope of palliation.

ologist or clinic will see an equal proportion of all six types of case listed in Table VIII. Indeed the *relative* frequency of these six groups is approximately as follows (according to Levin, Paterson *et al.*):

Breast	8	Colon and rectum	4.5
Skin	5	Lip and mouth	1
Uterus (cervix)	4	Uterus (fundus)	1

If the figures in Table VIII are corrected for this relative incidence, we find the results shown in Table IX.

TABLE IX

ESTIMATED PERCENTAGE OF CASES SUITABLE FOR INITIAL TREATMENT BY VARIOUS METHODS, CORRECTED FOR RELATIVE FREQUENCY OF DIFFERENT TYPES OF CANCER

a. Radical surgery	32%
b. Radical surgery and irradiation	13%
c. Radical irradiation	31%
d. Palliative surgery	9%
e. Palliative irradiation	8%
f. Medical only	7%
	100%

It therefore seems quite evident that radiation therapy is at least of equal importance with surgery in the best care of the vast majority of cancers curable at the present time.

This fact, that irradiation is of equal importance to surgery, in the cure of accessible cancers, indicates the need for a reorientation of attitude towards Tumor

Services and allied endeavors. A medical group or clinic which lists a dozen surgeons and but one radiologist on its staff is not unusual at the present time. Can this be regarded as modern, from the point of view of providing a good cancer therapeutic service?

Joint treatment: In cases which require a combination of surgical and radiological procedures, it is most desirable, if not essential, that *consultation* be had *prior* to the initiation of treatment. In this manner, the place and timing of the different techniques can be planned with maximum benefit to the patient. One of the major and recurring problems in all fields is that "what is familiar to one may not be at all familiar to others." The Consultative Tumor Board, with follow up service, is a valuable method of keeping practitioners informed as to the potentialities of the various cancer therapeutic disciplines. This is especially so since the general practitioner is reported to see, on the average, only 4 new cases of cancer per annum.

RELATIVE MERITS OF DIFFERENT IRRADIATION TECHNIQUES

The best technique is that which will deliver the minimum effective lethal dose to the involved area, with the least injury to the surrounding tissues. Since there is no discernible difference in biological effect between different qualities of radiation from 50 kv. to 1,000 kv., provided tissue

dose and rate of administration are identical, the source of radiation is obviously not of critical importance. One may cure accessible cancers with 60 kv., 100 kv., or 500 kv. apparatus, provided the physical properties of the beam are fully appreciated and are correctly employed. Some years ago Truesdale⁸ observed that: "In the application of surgical treatment for cancer, the excellence of instruments is of little value unless the surgeon is cancer-minded in their use." A similar principle applies to irradiation.

In this connection it may be observed that just as surgery is best performed by a surgeon, so, I believe, is radiation best applied by a radiologist. One cannot perform radical surgery or radical irradiation by prescription, nor does a six months course in either discipline always make one a joint specialist! Sound cancer care would seem to require the availability and cooperation of both surgeons and radiologists.

Radium is essential for the care and cure of most cases of cancer of the cervix uteri, many cases of cancer of the uterus corpus, lingual cancer, maxillary antrum tumors and cancer in a few other sites. Ordinary, flexible 200 kv. roentgen-ray apparatus provides the main roentgen weapon for efficient assault upon suitable cases of intraoral, laryngeal and mammary carcinoma, as well as the treatment of the large group of tumors of many other sites suitable only for palliation.

Supervoltage techniques have occasional advantage in the treatment of certain inaccessible, deep-seated tumors. Beams from betatrons and synchrotrons are still of incompletely explored usefulness. Radiations from unstable isotopes are invaluable in research, but of very limited value in cancer therapy. Irrespective of the radiation equipment available, it is the training and experience of the radiologist which is of primary importance: *he* is the "facility"! At the risk of being tautologic, I would repeat these words: a knife never cured a cancer—a *surgeon* using a knife cured it;

conversely a roentgen-ray beam never cured—a radiologist using it did.

PALLIATIVE TREATMENT

Just as many types of cardiovascular and renal disease are incurable when first discovered or brought to medical attention, so are approximately 50 per cent of cancers at the present time. The problem of palliation is therefore great. Judicious surgery and irradiation are again our principal weapons—chemotherapy and other aids being of secondary use, except in a few genital tract tumors.

It is natural that the failure which occurs with any one method in a certain proportion of cases, should cause patients and physicians to try out every new "discovery." However, such excursions should be tempered with discretion and preferably preceded by valid clinical tests. Take, for example, the recent enthusiasm for steroids in the treatment of bone metastases from breast cancer. The yield, in terms of pain relief and temporary healing of the lesions, is about 45 per cent with steroids (testosterone, stilbestrol, etc.), while with properly applied roentgen irradiation it is fully 70 per cent.

RELATIVE YIELDS IN CANCER WORK

The amount of energy devoted to the attempted control of gastric cancer is now very great. Experiments in mass survey roentgen methods are afoot: persons with certain types of anemia and hypochlorhydria are being examined periodically: gastric ulcers are being resected with increasing frequency, and total gastrectomy is a common operation. Despite all this activity the five year absolute cure rate is still not much above 3 per cent.

On the other hand, the control of uterine cervical cancer (which is nearly as common as stomach cancer—there being about 75 cervix cases for every 100 gastric cancers) arouses only moderate interest. It is essentially a radiological disease, and at least 40 per cent of all cases properly treated survive for five years. Is it not

important to stress the great salvage obtainable in this type of cancer?

SUMMARY

The roles of surgery and irradiation in the cure and care of cancer are complementary and not competitive. The most certain cure for cancer is complete surgical removal or complete destruction by irradiation.

Modern radiation therapy, like modern surgery, is greatly improved in performance, thanks to increasing experience, better follow-up and the use of modern biological adjuncts. If the commonly curable cancers are considered—those of the skin, oral cavity, breast, uterus and rectum—the relative indications for the two methods are virtually equal. That is, while surgery is the curative method of choice in most breast and almost all rectal and rectosigmoid lesions, irradiation is indicated in most cutaneous, oral and uterine ones.

The cure rate in early accessible cancer is encouragingly high—from 65 per cent to 95 per cent of treated cases, depending on the site and type of tumor. The absolute five year clinical cure rate, all cases and stages considered, is estimated to be about 40 per cent in this accessible group.

Since approximately one-fourth of the cancers in males, and two-thirds of those in female patients are accessible, the magnitude of the problem, and the degree of improvement attainable with our present day knowledge may be readily visualized.

The role of radiology being of equal significance to that of surgery in the care and cure of these accessible tumors, it would appear sensible to suggest that the radiological staff have comparable representation and responsibility on tumor policy boards, and be numerically large enough to fulfill their part in the staffing of offices, hospitals and clinics which accept cancer patients for treatment.

The cure rate in inaccessible cancer is still low: tumors of the stomach, colon,

prostate or lung give a five year absolute clinical cure rate of less than 10 per cent. Since this group of tumors is roughly as large as the accessible group, the challenge is indeed great. The scalpel is our main hope of cure in early cases of these lesions; and the scalpel or ionizing beam our main hope of palliation in the remainder. In other words, the skillful, radical surgeon is still supreme in this field.

The surgical treatment of advanced visceral cancer and the chemotherapeutic approach to generalized tumors have captured the attention of many clinicians in recent years—to the depreciation of achievements in connection with the more common tumors. Sound thinking suggests that we now devote increasing attention to the curable cancers which can, by simple physical examination, be detected early, and by simple extirpation or irradiation often cured. Proper heed to this group should double our present over-all cure rate.

450 Sutter St.
San Francisco 8, Calif.

REFERENCES

1. ACKERMAN, L. V., and DEL REGATO, J. A. *Cancer*. C. V. Mosby Co., St. Louis, 1947, pp. 18-20.
2. American College of Surgeons, Registry of Cancer Cures, A. C. S., Chicago, Ill.
3. GRISWOLD, M. H. *Cancer control methods*. *J.A.M.A.*, 1948, 138, 881.
4. LEVIN, M. L., N. Y. *Cancer Reports* N. Y. State. See Ackerman and del Regato¹ (Incidence of cancer in living persons); also Haagensen, C. D., *J.A.M.A.*, 1948, 138, 195.
5. PATERSON, R. Report of Holt Radium Institute. Livingston, Edinburgh, 1946.
6. SMITHERS, D. W. *X-ray Treatment of Accessible Cancer*. Williams & Wilkins Co., Baltimore, 1946.
7. *Statistical Bull.* M. L. I. Co., N. Y., 1947.
8. TRUESDALE, PHILEMON E. *Cancer*, Mass. Ca. Comm., Boston, 1940.
9. STENSTROM, K. W., and BAGGENSTOSS, O. J., Results of surgery and radiation for cancer of breast with axillary metastases. *Acta radiol.*, 1947, 28, 633.
10. U. S. Census Reports. (Cancer mortality data.)

AN ANALYSIS OF THE PHYSICAL FACTORS CONTROLLING THE DIAGNOSTIC QUALITY OF ROENTGEN IMAGES*

PART V. UNSHARPNESS

By RUSSELL H. MORGAN, M.D.

BALTIMORE, MARYLAND

I. INTRODUCTION

MOST roentgenologists are familiar with the loss of detail which occurs in a roentgenogram when the anatomical structure under examination moves during exposure or when the target size of the roentgen tube is excessively large. This effect is

The sharpness of a roentgenographic image may be determined quantitatively by placing the film in a microdensitometer and measuring the density of the film as the image boundary is moved over the entrance slot of the instrument. A typical curve in which film density is plotted as a function of distance is shown in Figure 1. If the image were recorded with perfect sharpness, the relationship between density and distance would have been as shown in the dotted curve; i.e., an abrupt change in density would have occurred when the image boundary passed through the microdensitometer. Since no roentgenographic image is recorded with perfect sharpness, the transition in density is more gradual, like that shown by the solid curve.

The distance between the upper and lower points of inflection in the microdensitometric curve (points *A* and *B* in Fig. 1) constitutes the width of the image boundary. In general, images in which this distance is large appear less sharp than those in which the distance is small. Accordingly, the width of the image boundary is frequently referred to as the unsharpness of the image.

caused by the diminished sharpness with which roentgen images are recorded under these circumstances.

In addition to target size and anatomical movement, sharpness is also affected by inherent characteristics (e.g., graininess) of roentgenographic films and intensifying screens. Thus, the roentgenographic image of a carefully machined lead plate, when examined closely, will not present an entirely sharp border; instead, the transition in density across the image boundary will be gradual due to the finite size of the grains in the photosensitive emulsion and in the fluorescent screens.

The interpretability of a roentgenographic image is profoundly influenced by its unsharpness. Images having a low level of unsharpness are perceived with excellent clarity, whereas those possessing a high level of unsharpness are seen poorly. It will therefore be well to examine carefully the various factors which contribute to roentgenographic unsharpness so that exposure conditions may always be chosen in which their effect is small.

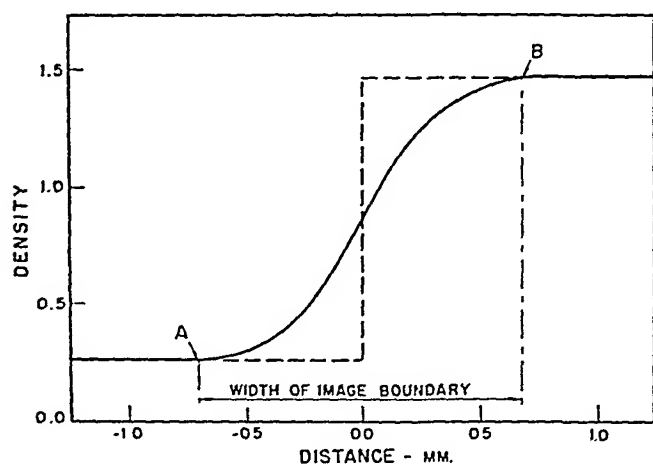


FIG. 1. Manner in which the density of a typical roentgenographic film changes as one progresses across an image boundary. Dotted lines indicate the form which would be taken by the curve if the image were recorded with perfect sharpness.

* From the Department of Radiology, The Johns Hopkins University and Hospital, Baltimore, Maryland.

II. THEORY OF UNSHARPNESS

The three principal factors which influence roentgenographic unsharpness include (1) the finite size of the target of the roentgen tube, (2) the movement of the anatomical part under examination and (3) the inherent characteristics of roentgenographic films and screens. Under most circumstances, two or more of these factors operate collectively to cause image unsharpness. However, before an understanding may be gained of the manner in which these factors operate together it will be necessary to consider each of them individually.

a. Target Size. The effect of target size on image unsharpness is clearly demonstrated by the schematic diagram shown in Figure 2 where *F* is the target of a roentgen tube, *O* is a partially radiolucent and motionless object and *R* is a roentgenographic film. It is apparent that all portions of the film to the left of the point x_0 receive a uniform exposure. Progressing to the right from x_0 , the film receives a

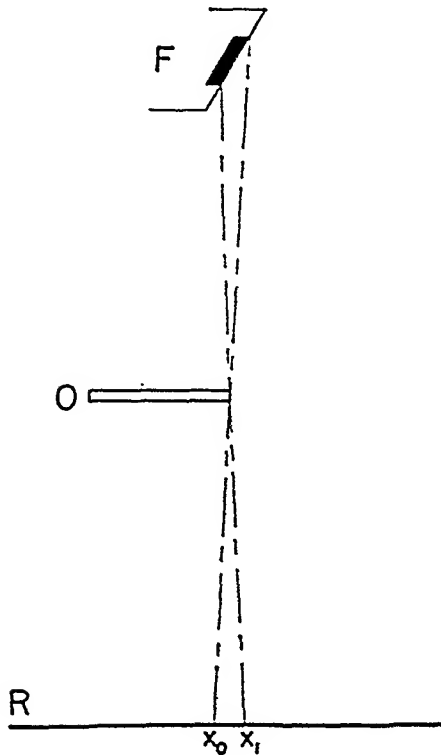


FIG. 2. Diagram illustrating the manner in which the finite size of the target of the roentgen tube causes unsharpness. *F*, target of roentgen tube; *D*, partially radiolucent object; *R*, roentgenographic film.

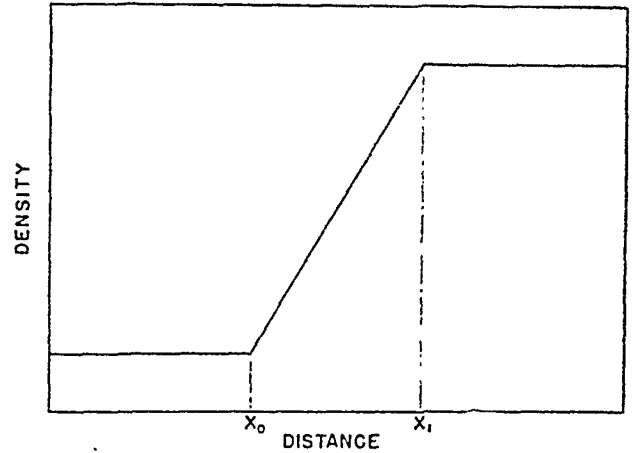


FIG. 3. Density vs. distance curve produced at the image boundary of the film exposed in Figure 2.

gradually increasing exposure as the target becomes uncovered, until the point x_1 is reached; beyond this point the film receives a uniform exposure. If the target is emitting uniformly over its surface, the intensity of the radiation reaching any point of the film between x_0 and x_1 is given by the equation

$$G_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)}{(x_1 - x_0)} + G_{x_0} \quad (1)$$

where G_{x_1} is the intensity at and to the right of point x_1

G_{x_0} is the intensity at and to the left of point x_0 and

x is the position of any point between x_0 and x_1 .

Since the exposure received by a film is equal to the product of the roentgen intensity by exposure time, the exposure received by any point of the film between x_0 and x_1 is therefore

$$E_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)t_a}{(x_1 - x_0)} + G_{x_0}t_a \quad (2)$$

Where t_a is the exposure time. Now the roentgenographic density produced in an exposed and processed film is essentially proportional to the exposure (See Fig. 4, part IV*). Therefore, the density at any point of the film between x_0 and x_1 is

$$D_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)kt_a}{(x_1 - x_0)} + G_{x_0}kt_a - c \quad (3)$$

* AM. J. ROENTGENOL. & RAD. THERAPY, 1946, 55, 627-633.

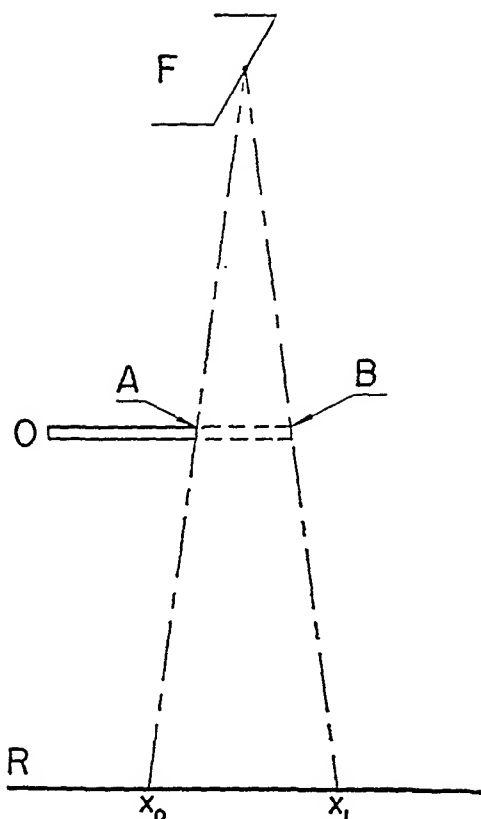


FIG. 4. Diagram illustrating the manner in which the movement of an object being roentgenographed causes unsharpness. F , dimensionless roentgen tube target; O , partially radiolucent object; R , roentgenographic film.

where k and c are constants.

It is evident from equation (3) that as one progresses from x_0 to x_1 , density increases linearly with distance if the roentgenographic film has no inherent unsharpness of its own. The microdensitometric curve at the image boundary will therefore have the form illustrated in Figure 3. The distance between the upper and lower points of inflection of this curve is clearly $x_1 - x_0$. Therefore the geometric unsharpness produced by the finite size of the target of the roentgen tube is given by the equation

$$U_g = x_1 - x_0 = \frac{Fm}{d - m} \quad (4)$$

where F is the target size, m is the object-film distance and d is the target-film distance.

b. Anatomical Movement. The manner in which anatomical movement, alone, may produce image unsharpness is demonstrated schematically in Figure 4, where F

is the dimensionless target of a roentgen tube, O is a partially radiolucent object whose edge moves from position A to position B , during exposure and R is a roentgenographic film. It is clear that all portions of the film to the left of the point, x_0 receive a uniform exposure. To the right of x_0 , the film receives an additional exposure, the amount of which depends on how long that portion of the film remains uncovered during the exposure.

If the object moves uniformly across the film, the intensity of the radiation reaching any point of the film to the right of the point x_0 , and to the left of the point x_1 (the position of the projected edge of the object at the end of the exposure), is given by the equation

$$G_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)}{(x_1 - x_0)} + G_{x_0} \quad (5)$$

where G_{x_1} and G_{x_0} have the same significance as in equation (1). Now equation (5) has the same form as equation (1). Therefore, equations (2) and (3) apply also to the condition where a uniformly moving object passes over a roentgenographic film during exposure. Accordingly, the microdensitometric curve at the image boundary will have the form given in Figure 3 and the unsharpness value produced by the moving object will be $x_1 - x_0$; that is,

$$U_m = x_1 - x_0 = vt_a = \frac{v_0 t_a d}{d - m} \quad (6)$$

where v_0 is the velocity of the object O and v is the velocity of projected edge of the object's shadow on the film.

The foregoing derivation assumes that the object being roentgenographed moves uniformly during exposure. In practice, however, this situation seldom occurs. Instead, the movement is likely to be quite complex; furthermore, the degree of complexity is likely to vary considerably from one examination to another. An analysis of such movements therefore is most difficult and it is necessary to resort to the above derivation as a first approximation to actual roentgenographic conditions.

c. Inherent Unsharpness. As stated in earlier paragraphs, the roentgenographic image of a motionless object, exposed with an effectively dimensionless roentgen tube target is never perfectly sharp but instead produces a microdensitometric tracing similar to that illustrated in Figure 1. Unlike the curve shown in Figure 3, this curve is sigmoid in shape, a characteristic which will have considerable interest in later paragraphs.

d. Effect of Several Unsharpness Factors Operating Simultaneously. Equation (3) specifies the unsharpness conditions when a stationary object is roentgenographed with a target of finite size or when a moving object is exposed with a dimensionless roentgen tube target. When target unsharpness and movement unsharpness occur simultaneously, the relationship is no longer valid.

Figure 5 illustrates schematically the prevailing conditions during the roentgenography of a moving object by a roentgen tube having a target of finite size. As in Figure 2, F represents the target of the roentgen tube, O is a partially radiolucent object and R is the roentgen film. During the exposure the object moves, let us assume uniformly, from A to B . From the diagram it is evident that the intensity of the radiation reaching the film at all points to the left of x_0 is uniform. When the object is at position A , the intensity of the radiation at any point on the film between points x_0 and x_1 is that given in equation (1). However, as the object moves from position A to position A_1 , the intensity of the radiation at points between x_0 and x_1 gradually diminishes with time and the exposure received by any portion of the film within these limits is given by the function

$$E_x = \int_0^{t_a} G_{tx} dt \quad (7)$$

where G_{tx} is the intensity of the radiation falling on any point, x , of the film between x_0 and x_1 at the instant, t , and t_a is the exposure time of the film. Now, from equa-

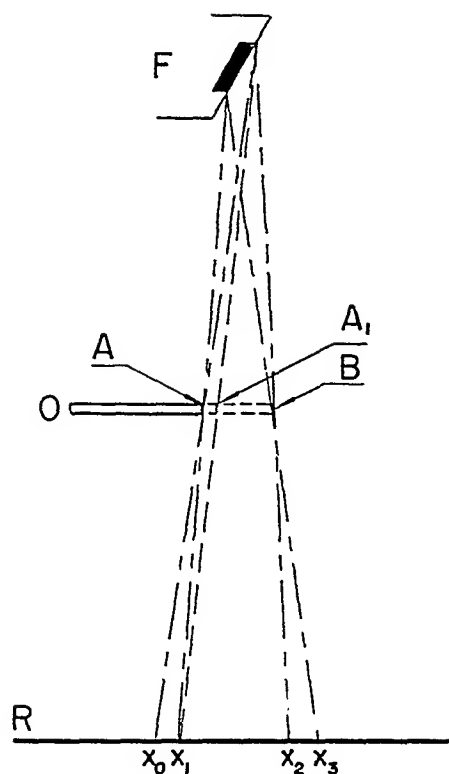


FIG. 5. Diagram illustrating the manner in which the finite size of the target of the roentgen tube and movement of the object being roentgenographed operate collectively to cause unsharpness. Symbols are the same as in Figures 2 and 4.

tion (1) and an inspection of Figure 5, it is evident that the value of G_{tx} is simply

$$G_{tx} = \frac{(G_{x_1} - G_{x_0})(x - x_0 - vt)}{(x_1 - x_0)} + G_{x_0} \quad (8)$$

for values of

$$t \leq \frac{x - x_0}{v}$$

and

$$G_{tx} = G_{x_0} \quad (8a)$$

for values of

$$t > \frac{x - x_0}{v}$$

where G_{x_1} and G_{x_0} have the same significance as in equation (1) and where v is the velocity with which the image boundary of the object, O , travels across the film; that is,

$$v = \frac{x_1 - x_0}{t_1} \quad (9)$$

where t_1 is the time needed for the object O , to travel from A to A_1 . When equations (8) and (8a), within their respective limits, are substituted in equation (7)

$$E_x = \int_0^{t_x} \frac{(G_{x_1} - G_{x_0})(x - x_0 - vt)}{(x_1 - x_0)} \cdot dt + \int_0^{t_a} G_{x_0} \cdot dt \quad (10)$$

where

$$t_x = \frac{x - x_0}{v}.$$

Therefore when the integration is completed, it will be seen that the exposure received by any point, x , of the film between x_1 and x_0 is

$$E_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)^2 t_1}{2(x_1 - x_0)^2} + G_{x_0} t_a \quad (11)$$

where t_a is the total exposure time of the film. Since the relationship between roentgenographic density and exposure is essentially linear, the density at any point x , between x_0 and x_1 is

$$D_x = \frac{(G_{x_1} - G_{x_0})(x - x_0)^2 k t_1}{2(x_1 - x_0)^2} + G_{x_0} k t_a - c \quad (12)$$

where k and c are constants. It will be observed that within the region between x_0 and x_1 , density varies as the *square of the distance* across the image boundary.

The density within the image boundary region between x_1 and x_2 may be readily determined by considering the time of exposure within this region as consisting of three phases: (1) the time during the initial stages of the exposure when the film receives radiation directly from the roentgen tube; (2) the time during the middle stages of the exposure when the border of the moving object and the finite target size combine to project on the field a penumbral shadow and (3) the time during the late stages of the exposure when the film receives radiation of uniform intensity through the body of the moving object.

In the first stage the exposure received

by the film at some position, x , between x_1 and x_2 (Fig. 5) is given by the equation

$$E_{xa} = G_{x_1} t' \quad (13)$$

where G_{x_1} has the same significance as formerly and t' is the time required for the object, O , to move from its starting position, A , to a position at which its border begins to produce a penumbral shadow of the target at the point, x . This time, of course, is a function of the velocity of the object and is given by the equation

$$t' = \frac{x - x_1}{v} \quad (14)$$

where v , the velocity, is defined by equation (9). Therefore, equation (13) becomes

$$E_{xa} = G_{x_1} t_1 \cdot \frac{(x - x_1)}{(x_1 - x_0)} \quad (15)$$

In the second stage of the exposure the intensity of the exposing radiation varies with time as the object covers more and more of the presenting surface of the target from the film. The value of the exposure received by the film therefore may be determined by employing similar methods to those used in deriving equation (11). From equation (8) it is evident that the intensity of the exposing radiation at any instant is given by the equation

$$G_{xb} = \frac{(G_{x_1} - G_{x_0})(x_1 - x_0 - vt)}{(x_1 - x_0)} + G_{x_0} \quad (16)$$

Therefore, the exposure received by the film during this phase of the exposure is

$$E_{xb} = \int_0^{t_1} \frac{(G_{x_1} - G_{x_0})(x_1 - x_0 - vt)}{(x_1 - x_0)} dt + \int_0^{t_1} G_{x_0} dt$$

or

$$E_{xb} = \frac{(G_{x_1} - G_{x_0}) t_1}{2} \quad (17)$$

During the third phase of the exposure the intensity of the exposing radiation is again constant at a value G_{x_0} . The dura-

tion of this phase is equal to the total length of exposure less the time necessary to complete phases (1) and (2). Therefore, the exposure received by the film during phase 3 is given by the equation

$$E_{xc} = G_{x_0} \left(t_a - \frac{(x - x_0)}{(x_1 - x_0)} t_1 \right). \quad (18)$$

When equations (15), (17), and (18) are added, the total exposure received by any point, x , of the film between x_1 and x_2 is

$$E_x = G_{x_0} t_a + \frac{(2x - x_1 - x_0)(G_{x_1} - G_{x_0})t_1}{2(x_1 - x_0)}. \quad (19)$$

The density of the film at this point will therefore be

$$D_x = G_{x_0} k t_a + \frac{(2x - x_1 - x_0)(G_{x_1} - G_{x_0}) k t_1}{2(x_1 - x_0)} - c. \quad (20)$$

Equation (20) may also be written in the form

$$D_x = G_{x_0} k t_a + (2x - x_1 - x_0)(G_{x_1} - G_{x_0}) k / 2v - c. \quad (20a)$$

It will be observed that within the region between x_1 and x_2 density increases linearly as the image boundary is crossed. Indeed the rate of increase is identical to that

which would occur if the only unsharpness present were that due to movement of the object.

An expression giving the density within the region between x_2 and x_3 may be easily derived by employing methods similar to those used in the derivation of equation (11) and takes the form

$$D_x = G_{x_1} k t_a - \frac{(G_{x_1} - G_{x_0})(x_3 - x)^2 k t_1}{2(x_3 - x_2)^2} - c. \quad (21)$$

Here, as in the region between x_0 and x_1 , the density varies as the square of the distance across the image boundary.

In the foregoing analyses, it was assumed that the penumbral shadow of the object remained equal in width as the object moved from A to B . Such an assumption, however, is valid when the target size and object are small in respect to target-object and target-film distances. Also, it was assumed that the unsharpness due to movement of the object was greater than that due to the size of the target. However, if the reverse were true, it could easily be shown that equations (12), (20) and (21) would be equally valid.

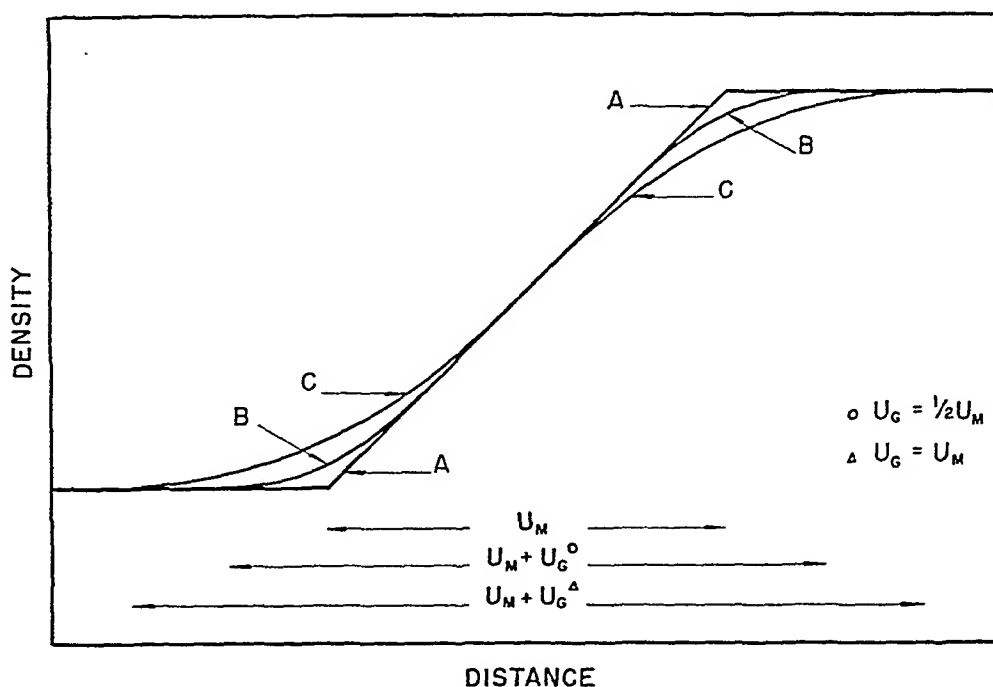


FIG. 6. Density of a film at any point within the image boundary produced by a moving object and roentgenographed with a roentgen tube target of finite size. Curve A , target unsharpness is zero; curve B , target unsharpness is equal to one-half the value of movement unsharpness; curve C , target unsharpness and movement unsharpness are equal.

The density of a film at any point within the image boundary of a moving object roentgenographed with a target of finite size may be determined from equations (12), (20), and (21). In Figure 6, such curves are plotted for three combinations of target size and object movement. In curve *A*, one of the parameters is zero (relatively much smaller than the other); in curve *B*, one of the parameters has an unsharpness equal to one-half of that of the other; whereas in curve *C*, the unsharpnesses are equal. It will be observed that in each case the distance from the point of inflection of the curve below to the point of inflection of the curve above is equal to the sum of the individual unsharpness values ($U_m + U_o$). Therefore, the *total* unsharpness of an image, where several types of unsharpness are present, is equal to the sum of the individual factors; i.e.

$$U_t = U_1 + U_2 \cdots U_n \quad (22)$$

where U_t is the total unsharpness. Although equation (22) is mathematically valid, it apparently does not indicate the *observed* or *effective* unsharpness of the roentgenographic image. This fact was first discovered by Warren¹ several years ago. In his experimental studies, Warren prepared a series of films in which a uniformly moving lead plate was employed as a test object. Exposures were made without intensifying screens and with object movement and target size sufficiently high that the unsharpness contributed by the film was insignificantly low. Target unsharpness and movement unsharpness were varied independently of one another through a wide range. The films were then given to disinterested readers to grade in order of unsharpness. The correlation between the observations and equation (22) was rather poor, equation (22) tending to indicate an unsharpness considerably in excess of the observations. This led Warren to devise a number of formulae by which effective unsharpness could be predicted when two types of unsharpness are present.

One of the most striking observations

which may be made from Warren's material is the consistency with which effective unsharpness values seldom differ greatly from the largest of the two individual unsharpness levels (target and movement unsharpness) present in his experimental films. Such a situation would not be surprising if one of the unsharpness values were always considerably greater than the other. The effect was observed, however, even when the two values were almost equal; that is, when two types of unsharpness were present and equal to one another, the effective unsharpness was identical to that which would have occurred if only one type of unsharpness were present.

In an effort to explain Warren's findings, the relationships expressed in equations (3), (12), (20), and (20a) were recently given critical review by the author. From this study several observations were made which seem to indicate that the effective unsharpness value of an image is dependent on something much more fundamental than heretofore has been contemplated. *Indeed, it appears that the effective unsharpness of an image is governed by the maximum slope of the microdensitometric curve obtained at the image boundary.* To illustrate this, let us examine the conditions given by the several equations in question.

When one type of unsharpness (target or movement) is present the maximum slope of the density vs. distance curve at the image boundary is obtained by differentiating equation (3); that is,

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{(G_{x_1} - G_{x_0})kt_a}{x_1 - x_0} \quad (23)$$

But

$$(G_{x_1} - G_{x_0})kt_a = D_1 - D_0$$

where D_1 is the density in the background of the film and D_0 is the density within the image of the roentgenographed object. Also, $x_1 - x_0 = U_o = U_m$. Therefore,

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{D_1 - D_0}{U_o} = \frac{D_1 - D_0}{U_m} \quad (24)$$

Now if two types of unsharpness are present and the value of one (e.g. movement unsharpness) is greater than the other, the maximum slope of the density vs. distance curve is obtained by differentiating equation (20a); that is,

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{(G_{x_1} - G_{x_0})k}{v} \quad (25)$$

When v is eliminated from equation (25) by means of equation (6)

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{(G_{x_1} - G_{x_0})kt_a}{U_m} = \frac{D_1 - D_0}{U_m} \quad (26)$$

Thus, it is clear from equation (26) that the maximum slope of the curve is a function only of movement unsharpness, that is, the maximum slope again would be determined by the larger unsharpness level.

Finally, if the two unsharpness levels are made equal an examination of Figures 5 and 6 reveals that the maximum slope of the density versus distance curve within the image boundary may be determined by differentiating equation (12) and setting the value of x equal to x_1 and the value of t_1 equal to t_a ; that is

$$\begin{aligned} \left[\frac{dD}{dx} \right]_{\max} &= \frac{(G_{x_1} - G_{x_0})kt_a}{(x_1 - x_0)} = \frac{D_1 - D_2}{U_m} \\ &= \frac{D_1 - D_2}{U_g} \end{aligned} \quad (27)$$

Thus, when the two unsharpness levels are equal the maximum slope of the curve is the same as though only a single unsharpness were present.

From the foregoing, there is a compelling similarity in the manner in which the maximum slopes of the image boundary curves and the effective unsharpnesses of roentgen images behave. When two types of unsharpness are present, the combined effect appears to be controlled only by the larger of the two unsharpness levels. From this, one may reasonably postulate that an observer's impression of an image boundary is governed by the maximum slope of the boundary. Such a postulate has been further

supported recently by additional mathematical analyses and experimental studies of conditions where three types of unsharpness (target, movement, and inherent) are present.

Before discussing these analyses, it should be recalled that in the derivation of equations (20) and (20a) target unsharpness and movement unsharpness were assumed to be linear functions as shown in Figure 3. However, it will be seen in Figure 1 that inherent unsharpness is not a linear function and therefore the mathematical analysis cannot follow a simple extension of the previous derivations to include a third type of linear unsharpness. Now it will be seen from Figure 1 that the form of the inherent unsharpness curve is similar to that of curve *B* in Figure 6; that is, inherent unsharpness behaves as though it were the result of *two* linear types of unsharpness operating simultaneously. Accordingly, our analysis must be extended to include four types of linear unsharpness.

By pursuing operational mathematics similar to those followed earlier in this paper it may be shown that when four equal and linear types of unsharpness are present, the maximum slope of the image boundary curve is given by the equation

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{2(D_1 - D_2)}{3U} \quad (28)$$

where U is the value of any one of the unsharpness levels.

When one unsharpness level is greater than the others, equation (28) approaches

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{D_1 - D_2}{U_{\max}} \quad (29)$$

Thus, when four linear types of unsharpness are present, the maximum slope of the image boundary curve as determined from equations (28) and (29) is equal to that which would have been produced by the largest factor alone except when all four unsharpnesses are equal; then, the maximum slope is 33 per cent less than that produced by any one of the factors singly.

If the perception of unsharpness is governed by the maximum slope of the density vs. distance curve at an image boundary, one would expect from the foregoing calculations that when target, movement, and film-screen unsharpness are contributing equally to an unsharpness level, effective unsharpness will be somewhat less than 50 per cent greater than that produced by any one of the unsharpness factors alone. Effective unsharpness, of course, should not exhibit the full 50 per cent increase predicted by equation (28) since inherent unsharpness does not behave like two equal linear unsharpnesses operating simultaneously as considered in the development of equation (28) but instead like two linear unsharpnesses in which one has about twice the magnitude of the other. It may easily be shown that this characteristic should reduce the effective unsharpness value several per cent depending on the exact form of the density vs. distance curve of the film-screen combination being used.

Klasens² has recently conducted experiments to determine visually the relation between effective unsharpness and the values of three individual unsharpnesses, including film-screen unsharpness, and has found that when the three degrees of unsharpness are equal, effective unsharpness is about 45 per cent greater than that produced by any one of the unsharpness factors alone. Such close agreement between observed and theoretical results seems to give strong support to the foregoing postulate regarding the perception of image boundaries. These workers have also shown that when one unsharpness factor is larger than the remainder, effective unsharpness is identical to that which would have been produced by the largest factor. *It, therefore, is clear that effective unsharpness is not equal to the sum of the individual unsharpness values but instead is seldom greater than the largest of these values.*

This conception of unsharpness has far-reaching implications in many roentgenologic problems. It illustrates, for example, that there are limits to which effective

unsharpness may be reduced by decreasing the unsharpness of a single factor. Thus when target size is made smaller, unsharpness becomes smaller until target unsharpness equals film or movement unsharpness, whichever is the larger. *Reducing target size still further effects no change in the appearance of a roentgenogram.* The same

TABLE I
UNSHARPNESS CHARACTERISTICS OF NINE COMMERCIAL
BRANDS OF INTENSIFYING SCREENS

Screen	Unsharpness
Patterson Detail	0.17 mm.
Patterson Par Speed	0.30 mm.
Patterson High Speed	0.33 mm.
Eastman Kodak High Definition	0.26 mm.
Eastman Kodak Fine Grain	0.29 mm.
Eastman Ultra Speed	0.32 mm.
Buck Detail	0.23 mm.
Buck Mid Speed	0.25 mm.
Buck Extra Speed	0.28 mm.
Patterson Type "D"	0.48 mm.
U. S. Radium 666-D	0.55 mm.

limitations also apply to movement unsharpness; that is, there is nothing to be gained by reducing movement unsharpness below the levels of target unsharpness or inherent film or film-screen unsharpness. Indeed it is clear that the objective of the roentgenologist when facing the technical problems of unsharpness in his clinical films should be the maintenance of target unsharpness and movement unsharpness at values equal to or slightly smaller than inherent film or film-screen unsharpness (see Table I). Effort expended in reducing these values to lower levels is largely wasted as far as practical results are concerned.

The concept also affects the method by which the inherent unsharpness of a roentgenographic film or film-screen combination should be measured. In equations (24), (26), (27) and (29), the relationship between unsharpness and the maximum slope of the density vs. distance curve takes the form

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{D_1 - D_0}{U} \quad (30)$$

When equation (30) is rearranged

$$U = D_1 - D_0 / \left[\frac{dD}{dx} \right]_{\max} \quad (31)$$

But

$$\left[\frac{dD}{dx} \right]_{\max} = \frac{D_1 - D_0}{\Delta x} \quad (32)$$

where Δx is equal to the interval along the distance-axis between the intercepts of a line drawn at the maximum slope of the unsharpness curve (density vs. distance curve) with the upper and lower density levels. Therefore

$$U = \Delta x. \quad (33)$$

That is, the inherent unsharpness of a roentgenographic film or film-screen combination is equal to the distance between the intercepts of a line drawn at the maximum slope of the unsharpness curve with the upper and lower density levels. Therefore, the inherent unsharpness of a roentgenographic film or film-screen combination should be measured by roentgenographing on the film or film-screen combination under test a straight-edge composed of some relatively opaque material and by making a microdensitometric tracing across the image boundary appearing on the film (see Fig. 7). A line should then be drawn at the maximum slope to the curve and the intercepts of the line with the upper and lower density levels noted (points *A* and *B*, Fig. 7). The desired unsharpness value is the distance between the two points, measured along the distance-axis of the graph.

In Table 1 are listed the inherent unsharpness data of a typical roentgenographic film exposed with nine brands of intensifying screens. Since the granularity of intensifying screens is so much greater than that of roentgenographic emulsions, data for other brands of film are identical to those shown in Table 1. These data were derived by roentgenographing a carefully machined lead plate on each material studied. The films after processing were examined microdensitometrically and un-

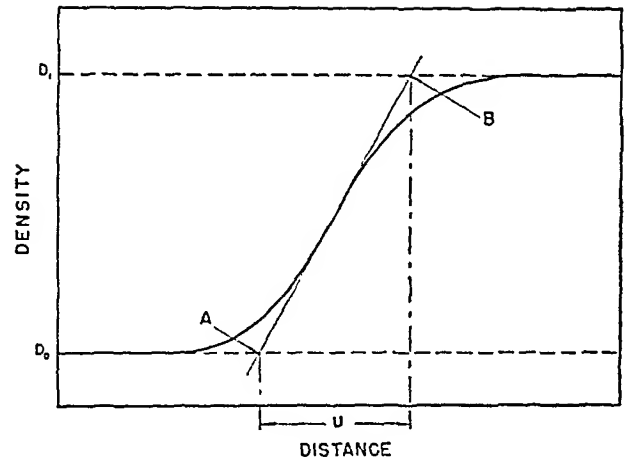


FIG. 7. Graphical illustration of method for measuring the inherent unsharpness of a roentgenographic film. *C*, density vs. distance curve occurring across image boundary appearing in the film; *A*, *B*, line drawn tangentially to maximum slope of curve; *U*, unsharpness value, as given by the difference between the intercepts of the line (*A*, *B*) and the upper and lower density levels.

sharpness curves prepared. Unsharpness values were then determined according to the method outlined above.

In all of the above determinations, the films were given sufficient pre-exposure to raise the density of the films beneath the object to a value of 0.8. This density was chosen because it lies near the mid-point of the useful range of film blackening. Accordingly, the data are fairly representative of conditions occurring in roentgenographic practice.

SUMMARY

The images recorded in a roentgenographic film do not appear completely sharp to an observer because of the finite size of the target of the roentgen tube, and the graininess of the film and screens with which the roentgenogram is made. Movement of the objects under examination also contributes to image unsharpness. Until recently it has been thought that when two or more types of unsharpness (target, movement or inherent film-screen unsharpness) occur simultaneously, the overall or effective unsharpness is equal to the sum of the individual unsharpness values. Recent experimental work, however, does not support this belief; indeed, it appears that

when two or more types of unsharpness are present in a film, the effective unsharpness is simply equal to the value of the largest of the several factors except under the condition when all are equal. Then the effective unsharpness value rises slightly.

This concept of unsharpness has far-reaching implications in many roentgenologic problems for it indicates that there are limits to which effective unsharpness may be reduced and the clarity of roentgenographic images improved by decreasing the unsharpness of a single factor. For example, when target size is made smaller, unsharpness becomes smaller until target unsharpness equals film or movement unsharpness, whichever is the larger. Reducing target size still further effects no change in the appearance of the roentgenogram. The same limitations also apply to movement unsharpness. Thus it appears that the roentgenologist, when facing technical prob-

lems of unsharpness in his clinical films, should try to maintain target unsharpness and movement unsharpness (factors over which he can exert control) at values equal to or slightly smaller than the inherent unsharpness of his films and screens. Effort expended in reducing these values to lower levels is largely wasted as far as practical benefits are concerned.

Inherent unsharpness values of several roentgenographic films and film-screen combinations are tabulated in the paper.

Johns Hopkins Hospital
Baltimore 5, Md.

REFERENCES

1. WARREN, S. R., JR. Roentgenographic unsharpness of the shadow of a moving object. *Radiology*, 1937, 28, 450-465.
2. KLASSENS, H. A. Measurement and calculation of unsharpness combinations in x-ray photography. *Philips Res. Rep.*, 1946, 1, 241-249.



THE EXTENDED TUBE TECHNIQUE IN INTRA-ORAL ROENTGENOGRAPHY

By ROBERT M. APPLEMAN, D.D.S.

Walter G. Zoller Memorial Dental Clinic, University of Chicago

CHICAGO, ILLINOIS

MOST intra-oral roentgenograms are very inadequate, since they fail to exemplify conditions as they actually exist in the mouth. Although it is true that most dental offices today have roentgen-ray machines, as many different types of results are obtained from them as there are dentists using the machines. There are two main reasons for this condition:

(1) The technique of exposing dental films has in the past been a mixture of the knowledge obtained in school and the technique as taught by dental supply salesmen. The end result of such haphazardly learned methods is the production of more inaccurate roentgenograms than true ones.

(2) The average dental machine has a focal distance of approximately 8 inches. With such a focal distance the rays emitted are not parallel but diverge beyond the focal point producing a distorted image upon the film. If we are to render a service to our patients which portrays the conditions as they actually exist, then we must use a technique which will produce those results. Since roentgenograms are one of the main links in the chain of oral diagnosis it is of utmost importance that nothing but the best possible films be used. How many dentists would be willing to measure the image of a tooth produced upon a roentgen film and the actual extracted tooth, and expect to obtain the same measurement? In most instances there would be either a foreshortening or an elongation of the image upon the film. Most of us are attempting to make interpretations of such roentgenograms as this. It must be agreed that most intra-oral roentgenograms are very inadequate.

Dr. Gordon Fitzgerald, Associate Professor of Oral Roentgenology, University

of California, has developed a technique whereby any dentist, with any type of a dental roentgen-ray machine, can reproduce upon a roentgen film an image of conditions as they actually exist in the mouth, and do it repeatedly. In his work there is nothing particularly new, for physicians have for years been taking roentgenograms of various parts of the anatomy with target distances of from 30 to 40 inches. They have known that the greater the target or focal distance from the object the more nearly parallel the rays and hence the less distortion of the image. Through his experiments Fitzgerald has found that a maximum distance of 20 inches in intra-oral work produces a true image upon the film and that greater distances have little bearing upon the end result. There are three other factors in this technique which differ from the standard procedures as taught in most dental schools:

(1) The plane of the dental film is always parallel to the long axis of the teeth being roentgenographed. *No* part of the film is *ever* bent.

(2) The film is placed in the mouth *away* from the teeth being roentgenographed. In most techniques the film is placed flat against the tissue forming an angle with the long axis of the teeth and a line bisecting this angle must then be penetrated perpendicularly by the rays.

(3) No definite angulation in the vertical is established for any exposure since all mouths are different.

With these thoughts in mind, it becomes a geometrical problem of placing the patient's head in the proper position, the film in the mouth in the proper position, and the tube of the roentgen machine in the proper relation to the plane of the film both vertically and horizontally. Since the

film is not placed flat against the tissue and should never be bent, it becomes evident that the use of the regular sized dental film ($1\frac{1}{4}$ by $1\frac{5}{8}$ inches) could not be used satisfactorily in the anterior part of the mouth. A narrowed film ($\frac{3}{4}$ by $1\frac{5}{8}$ inches) was developed for this region.

Central Lateral Incisor Region. In the upper arch, such a roentgenogram should portray the following:

(1) Central and lateral incisors centered upon the film, with the contacts open (unless the teeth are excessively overlapped).

(2) The mesial contact of the adjacent central incisor.

(3) Approximately the mesial third of the cuspid.

(4) The floor of the nasal passage.

(5) The median suture line.

(6) The incisive foramen and fossae.

To obtain images of these anatomical structures upon the film, two cotton rolls are placed side by side on the tube surface of the film packet. The patient's thumb supports the tissue edge of the film against the palate. A hinge-like freedom of movement is obtained and the springy characteristics of the cotton rolls allows the packet to be maintained out away from the teeth and parallel to their long axes. The patient bites the film gently to stabilize this retention. The inclinations of the long axes of the central and lateral incisors are the guides in film positioning, unless one or the other of the teeth is malpositioned in the arch. In that case the tooth with the more typical alinement is used. With the two cotton rolls between the film and the lingual surface of the crowns of the teeth and the tissues, the upper edge will be well back in the palate. The vertical angulation is directed so that the rays pass through the two parallel planes: i.e. the plane of the film and that of the long axis of the tooth. The horizontal angulation is so directed that the rays pass through the contact between the central and lateral incisors, or at right angles to the ridge if there is excessive overlapping or if the area is edentulous.

In order to determine the correct positioning of the roentgen tube in relation to the central beam, one must first describe what is meant by that term. The diameter of any circle bisects it. Two intersecting diameters establish the center of the circle at the point of their crossing. It is from this point that the central roentgen-ray beam is emitted. In the upper arch the central beam for all exposures should be directed at the apices of the teeth. As a general rule, an imaginary line drawn from the ala of the nose to the tragus of the ear will give the general apical line. In making all exposures the occlusal plane of the teeth must be perfectly horizontal and the sagittal plane of the face must be perpendicular to the occlusal plane of the teeth.

Upper Cuspid Region. In roentgenographing this region the following should be in evidence:

(1) The cuspid should be centered in the film.

(2) Mesially all or a good portion of the lateral incisor.

(3) Distally all or a good portion of the first bicuspid.

(4) The contact between the cuspid and lateral should be open (unless there is overlapping).

(5) The distal contact of the cuspid is usually found closed because of the superimposition of the shadow of the first bicuspid which is a wider tooth buccolingually.

(6) The nasal passage.

(7) The anterior wall of the maxillary sinus which joins to form the typical inverted "Y" that is so often in evidence in this region.

Two cotton rolls are again used as they were in the central lateral exposure. With the rolls placed between the film and the lingual surface of the crowns of the teeth and tissues, and the film parallel to the long axis of the cuspid, the tissue edge of the packet will be well back in the palate. The upper front or mesial corner will in many instances be closely adjacent to the opposite ridge. Care must be exercised to place the packet directly behind the cuspid tooth.

The vertical angulation is directed at right angles to the two parallel planes, and the horizontal angulation is directed so that the roentgen rays will pass through the height of contour on the labial surface of the cuspid crown before hitting the surface of the film. Usually this will bisect the angle formed by what is considered the corner of the dental arch.

In the posterior part of the upper arch a metal backing is used in conjunction with the film to insure its being kept parallel to the long axis of the teeth and to prevent any bending of the film. This backing consists of a piece of spring sheet metal, usually German silver, approximately the same size as the film. If the Bolin film is used, a shelf is bent at right angles to the plane of the metal in the horizontal direction upon which the film rests. This backing and the film are held in position by a film holder. A goiter hemostat, box lock 6½ inches long, makes an excellent holder. Over the beaks of this holder is placed a single-holed rubber cork which has previously been cut with a wet razor blade so that two of its sides are parallel, and which is used for the patient to bite upon. The backing is placed behind the film packet with the unbent edge slipped under the rubber jacket of the film. The opposite edge of the film rests against the shelf. With the film and backing in this position a full bite of the forceps is made as close to the shelf edge as possible. The handle of the film holder may then be rotated in the bite block so that the surface of the film may be placed parallel to the long axis of the teeth. The film is carried into the mouth in a horizontal position, and then rotated so that the tissue edge of the packet comes in contact with the palate in the proper position for the area being roentgenographed. At all times the bite block is kept against the incisal edge of the upper anterior teeth. The lower jaw bites firmly against the bite block, holding the film and film holder in the mouth and stabilizing the film placement.

Upper Bicuspid Region. The long axis

of the first bicuspid is used as a guide in positioning the film with the correct inclination, unless this tooth is missing or malpositioned. In that case the inclination of the second bicuspid is used. The bite block is pushed up tightly against the edge of the film. When positioned in the mouth so that the plane of the film is parallel to the long axis of the teeth, the tissue edge of the packet will be against the palate, beyond and parallel to the mid-suture line, away from the teeth being roentgenographed. The packet should be kept forward in the mouth also, so that the distal contact of the cuspid is shown on the film. With the film in this position, the handle of the holder will protrude from the mouth in the region of the two central incisors. The handle of the film holder as it protrudes from the mouth is at right angles to the packet. Therefore, when the vertical angulation is directed parallel to the plane of the handle of the instrument, a good guide is obtained for correct vertical angulation and the need for looking into the mouth to check the inclination of the film is eliminated. In obtaining the horizontal angulation the roentgen rays are directed through the contact between the first and second bicuspids, or at right angles to the ridge in this area if one or both of the teeth are malpositioned, or if the area is edentulous. Upon this film should be shown the following:

- (1) The distal contact of the cuspid.
- (2) The first and second bicuspids, with their contacts open.
- (3) The first molar and usually most of the second molar.
- (4) A portion of the anterior wall and the floor of the maxillary sinus, depending on the latter's position and anterior extension in the body of the dental ridge.

Upper Molar Region. In roentgenographing the upper molar region three different exposures are necessary to adequately portray all of the anatomical landmarks. The first of these is known as the lateral or first molar projection and upon this film the following should be in evidence.

(1) The distal half of the second bicuspid.

(2) The first and second molars.

(3) The third molar if fully erupted and in position.

(4) The maxillary tuberosity and the floor of the maxillary sinus.

(5) The hamular process of the sphenoid bone, and a portion of the coronoid process of the mandible.

The contacts between the second bicuspid and the first molar, and the second and third molars may be open; usually, however, the contact between the first and second molars will be closed. The film and backing are held by the film holder in the same manner as for the bicuspid exposure, except the rubber bite block is pulled back $\frac{1}{4}$ inch from the edge of the film. When the handle of the holder is rotated in the bite block so that the surface of the film is properly inclined, the film is ready for placement in the mouth. The inclination of the first molar is used as a guide in film positioning. Generally, the alinement of the long axis of the first molar shows the crown tipped to the buccal. When positioned in the mouth so that the plane of the film is parallel with the long axis of the first molar, the tissue edge (the edge that comes in contact with the palate) is beyond and parallel to the mid-suture line, away from the teeth being roentgenographed. The packet should be placed far enough back in the mouth so that not more than the distal half of the second bicuspid is shown on the film. The vertical angulation is such that the roentgen rays are directed at right angles to the plane of the film. Again the handle of the film holder will be at right angles to the film packet; therefore, when the vertical angulation is directed parallel to the plane of the handle of the instrument a good guide is obtained for the correct vertical angulation. The horizontal angulation is directed at right angles to the dental ridge in the molar region. The central beam is directed at the apex of the first molar, just under the prominence of the zygoma.

Upper Second Molar Region. The upper second molar exposure is known as the mesial oblique projection and upon this film the following should be in evidence:

(1) The distal half of the first bicuspid.

(2) The second bicuspid.

(3) The first and second molars.

(4) Part of the third molar if it is erupted and in position.

(5) The floor of the maxillary sinus, above or closely adjacent to the apices of the roots.

The contacts between the first and second molars should be open; the other contacts may or may not be open. Because of the direction of the horizontal angulation, the maxillary tuberosity will usually not be shown. The film is retained in the film holder in exactly the same manner as described previously, the handle of the film holder being rotated in the bite block to obtain the proper inclination of the film. The inclination of the second molar is used as a guide in film positioning. Generally the alinement of the long axis of this tooth shows the crown tipped to the buccal. When positioned in the mouth properly, the tissue edge of the packet is beyond the median suture line. Instead of being parallel to the mid-suture line, the tissue edge of the film forms with it a triangle, the apex of which is in the back of the mouth. This is accomplished by placing the film well back in the mouth as if for a lateral molar projection, by using the back or distal corner as a pivot, shifting the front or mesial portion of the film laterally across the mouth. The front corner of the packet will be close to the opposite dental ridge in the region of the second bicuspid. The film holder as it protrudes from the mouth will be in the region of the cuspid tooth on the opposite side of the mouth. The plane of the film holder is at right angles to the plane of the film, and thus if the vertical angulation is parallel to that, it will be correct. The horizontal angulation is directed through the contact between the upper first and second molars. This contact is usually in a mesial oblique direction. The cen-

tral beam is again directed at the ala-tragus line just under the prominence of the zygoma.

Upper Third Molar Region. The third molar projection is known as the distal oblique exposure and is taken primarily to bring out the following structures:

- (1) The distal half of the first molar.
- (2) The second molar.
- (3) All of the third molar regardless of its position in the tuberosity.
- (4) The tuberosity.
- (5) The distal wall and a portion of the floor of the maxillary sinus.
- (6) The hamular process of the sphenoid bone.
- (7) A portion of the coronoid notch.
- (8) The coronoid process of the ramus of the mandible.

Because of the direction of the horizontal angulation, usually all of the contacts are closed. The film and backing are held in the same manner as previously described for the other posterior projections. The inclination of the third molar is used as a guide in film positioning. Generally the inclination of the long axis of this tooth shows the crown tipped well to the buccal. When positioned in the mouth so that the plane of the film is parallel to the long axis of the third molar, the tissue edge of the packet is beyond the median suture line, forming an angle to it. The triangle which is formed this time is just the opposite of that formed in the mesial oblique projection with the apex of the triangle in the *front* of the mouth. The procedure for obtaining this is similar to that of the previous positioning, except that the front or mesial corner of the film is used as the pivot. The distal or back corner of the film will rest against the tuberosity on the opposite side of the mouth. When the film is in the correct position the handle of the instrument will protrude from the mouth in the region of the cuspid on the same side of the teeth being roentgenographed. By using the entire width of the distal portion of the upper arch for film placement, it is thus possible to project all of the maxillary

tuberosity on the film without using extreme vertical angulation, and without obscuring the structures and tissues present with the shadow of the zygomatic arch and process. The vertical angulation is directed at right angles to the plane of the film. The horizontal angulation is directed downward and forward just under the inferior border of the zygomatic arch, in a distal oblique direction toward the film. This notch can be felt on the side of the face about the width of a finger anterior to the condylar joint. The central beam is directed at the ala-tragus line just under the prominence of the zygomatic arch in the region of the third molar.

Lower Central Lateral Incisor Region. In the lower arch most of the films are again placed in such a manner that the object-film distance is greater than accomplished in most other techniques. The lower central lateral region should portray the following anatomical structures:

- (1) The central and lateral centered on the film with the contacts open (unless the teeth are overlapped).
- (2) The mesial third of the cuspid.
- (3) The mesial contact of the opposite central, if the mesio-distal width of the teeth will permit.
- (4) Sometimes the genial tubercle, shown below the roots of the centrals (ordinarily the mental ridge and the inferior border of the mandible do not show unless the superior-inferior dimension of the jaw is very short).

To obtain images of these structures satisfactorily the narrow film is used in this region. Two cotton rolls are placed side by side on the tube side of the film, the ends flush with the bottom edge of the packet. The side of the index finger is placed in the mouth behind the film and under the tongue to compress the tissues in the floor of the mouth. This pressure on the tissues allows the packet to be carried deeper behind the teeth. With the index-finger rigid, almost its entire length is placed diagonally across the back of the film, avoiding a lateral pressure against the

film. The finger acts only as a prop, and the springiness of the cotton rolls keeps the film away from the teeth and parallel to their long axes. A third cotton roll to bite on is placed on the upper back or distal corner of the film packet to prevent lateral tipping, and to push the film even deeper into the mouth. The patient is then instructed to bite, which will stabilize the film retention.

The inclination of the central and lateral is the guide in film positioning unless there is some malpositioning. In that case, the tooth with the most typical alinement is used. With the two cotton rolls between the film and the crowns of the lingual surfaces of the teeth, the tissue edge of the packet will be well back in the mouth under the tongue. In most instances there should be at least an inch, or slightly more, between the top of the film and the incisal edge of the teeth. The film packet must be directly behind the teeth in the direction of the horizontal angulation, and not more than $\frac{1}{4}$ inch of film should be showing above the incisal edges of the teeth when sighting in the direction of the vertical angulation. In all lower exposures it will be necessary to change the head position from that used in the upper arch so that the occlusal plane of the teeth is horizontal. The sagittal plane of the face must always be at right angles to the occlusal plane. The vertical angulation is directed at right angles to the two parallel planes; i.e. the plane of the film and those of the long axes of the teeth. The horizontal angulation is directed so that the roentgen rays pass through the contact between the central and lateral, or at right angles to the ridge if there is excessive overlapping or if the area is edentulous. The central beam should be directed at the apices of the teeth, usually about $\frac{1}{2}$ inch above the inferior border of the mandible in the male and $\frac{1}{4}$ inch above in the female.

Lower Cuspid Region. Placing the film for the cuspid region in the lower arch is accomplished in exactly the same manner as in the lower central-lateral region, except that the film is placed directly behind the

cuspid. Upon this film the following should be shown:

- (1) The cuspid centered on the film.
- (2) Mesially all or a good portion of the lateral.

- (3) Distally all or most of the bicuspid.

The contact between the cuspid and lateral should be open, unless there is overlapping, while the distal contact of the cuspid is usually found closed because of superimposition of the shadow of the first bicuspid, which is a wider tooth buccolingually. The roentgen rays in the vertical are directed at right angles to the two parallel planes and the horizontal angulation is directed so that it passes through the height of contour of the cuspid tooth. The central beam passes through the apices of the teeth.

Lower Bicuspid Region. Using the film with the long dimension placed *vertically*, the lower bicuspid region may be adequately portrayed with little discomfort to the patient. Upon this film the following should be shown:

- (1) The distal contact of the cuspid.
- (2) The first and second bicuspid, and all or most of the first molar.
- (3) The mental foramen and the anterior portion of the mandibular canal, which terminates in the mental foramen.

Unless there is overlapping of the teeth, all of the contacts should be shown open since their direction is at right angles to the dental ridge. Because of the vertical angulation employed, the first molar is usually shown to be slightly foreshortened.

Three cotton rolls and the index finger are used to maintain the film in the proper position in the mouth. Two cotton rolls, side by side, are placed between the tube surface of the film and the teeth and the tissues. The third cotton roll is used to bite on and is placed obliquely across the upper back corner of the film to prevent lateral tipping, and to sink the packet deeper into the mouth. The side of the patient's index finger, held rigid, is placed diagonally across the back of the film so that it will compress the tissue in the floor of the

mouth and secure greater depth. The finger should not exert any lateral pressure against the back of the film, as its only function is that of a prop. The springy action of the two cotton rolls holds the film away from the teeth and parallel to their long axes. The patient bites gently on the cotton roll to stabilize the film retention. The inclination of the first bicuspid, or of the second bicuspid if it is the more typical in alinement in the dental arch, is used as a guide in film positioning. Generally the alinement of the first bicuspid shows the crown tipped slightly to the buccal. The film and rolls are placed in the mouth so that the tissue edge of the packet is under the tongue, well away from the teeth, and far enough forward to secure the distal contact of the cuspid.

In the usual case, the tissue edge or lower front corner of the film will be against the dental ridge of the opposite side. The forward edge of the film will be in contact with the opposite first bicuspid tooth. It is vital to emphasize that only by placing the film in this position can images of the apices of the teeth be obtained without using excessive minus vertical angulation. Through this placement, the film will be forward in the arch securing the distal contact of the cuspid without resorting to film bending. The vertical angulation should be directed so that the roentgen rays are at right angles to the plane of the film and the horizontal rays are directed through the contact between the first and second bicuspids. If the contact is closed due to excessive overlapping the rays should be directed at right angles to the ridge in this area. The central beam should again be directed at the apices of the teeth.

Lower Molar Region. It will be noted that in all previous areas of the mouth the film packet has been positioned *away* from the teeth and tissues. This was accomplished to make it possible for the operator to position the film parallel to the long axis of the teeth, thus obtaining anatomical accuracy. The lower molar region is the one and only exception to this rule. In this area the film

can be placed against the dental ridge and still be parallel to the long axis of the teeth. To obtain the most satisfactory results it is necessary to make two exposures. The first of these being known as the lateral or first molar projection shows the following:

- (1) The distal half of the second bicuspid.
- (2) The first and second molars.
- (3) A portion or all of the third molar.
- (4) The mandibular canal in this area, and a portion of the retromolar triangle.
- (5) The internal and external oblique ridges superimposed on one another.

Unless one or more of the teeth are malpositioned in the arch, the contacts should be shown open. The patient's index finger and one cotton roll are used to hold the film in place and keep it parallel to the long axis of the teeth. The side of finger is placed diagonally across the back of the film with the end of the finger deep in the reflex. The back of the packet may have a tendency to tip up on occasions, so a cotton roll is placed obliquely across the upper distal corner of the film. When the patient bites the cotton roll gently, the back portion of the film is then held down in place and the entire film is stabilized in position. The inclination of the long axis of the first molar is used as a guide in film positioning. Clinical evidence reveals that in the majority of cases, the inclination of this tooth is toward the lingual. The vertical angulation is directed so that the roentgen rays pass at right angles to the plane of the film. Since the inclination in most cases is toward the lingual, many times a *plus* vertical angulation will be necessary. The horizontal angulation should direct the rays through the contact between the first and second molars or at right angles to the ridge if the area is edentulous. The central beam should be directed at the apices, at a point midway between the distal root of the first molar and the mesial root of the second molar.

Lower Molar Region—Second Exposure. The second molar exposure in the lower arch is known as the distal oblique or third

molar projection and should portray the following structures:

- (1) The distal half of the first molar.
- (2) The second molar.
- (3) The retromolar triangle and a portion of the ascending ramus.
- (4) All of the third molar regardless of its position in the mandible.
- (5) The mandibular canal and the internal and external oblique ridges superimposed one on another.

Because of the horizontal angulation, usually all of the contacts are closed. The film is retained in the same manner as that of the lateral molar projection. The inclination of the long axis of the third molar is used as a guide in film positioning. In many instances the long axis of the third molar is inclined in such a way that the crown tips toward the lingual, usually even more so than either the first or second molars. If the third molar is unerupted, imbedded, or impacted, then its relative position in the arch is usually higher, its crown being approximately on a level with the gingival third of the second molar roots. The film placement in this area is again the exception to the rule, the packet being placed well back in the reflex between the dental ridge and the tongue. If possible anatomically, the front edge of the film should be even with the lingual groove on the crown of the first molar. The vertical angulation should be directed in such a manner that the roentgen rays are at right angles to the surface of the film. The horizontal angulation should be such that the rays are directed toward the film in a distal oblique direction. The degree of angulation will depend upon how far back the film can be placed in the mouth, which is determined by the age of the patient, and the relative position of the third molar in the arch. The reason for projecting the rays with the vertical and horizontal angulation as indicated is to cast the shadows of the structures and tissues in this area downward and forward on the film.

Bite Wing Exposures. Most early carious lesions are more easily ascertained through

the use of the bite wing film, rather than in apical exposures. The films are taken in such a manner that the central roentgen-ray beam passes directly through the contact points of the teeth, all effort being exerted to show the mesial and distal surfaces of the teeth in question. It is for this reason that it is important in a complete examination to include the bite wing film. However, since these surfaces are not parallel in the entire posterior region, it is necessary to make two exposures. In the bicuspid region the film should show:

- (1) Mesially the distal halves of the cuspids.
- (2) Distally, all or a good portion of the second molars.
- (3) The crowns of the upper and lower teeth present.
- (4) The crest of the dental ridges.
- (5) The coronal third of the roots.

The film is placed in position well forward in the lower jaw, so that the distal portions of the cuspids will be shown. The tab rests on the occlusal surface of the lower teeth. The lower jaw is closed *slowly*, avoiding a protrusive or lateral bite, until the upper and lower teeth in centric hold the tab firmly. The operator's fingers are used to maintain control of the tab and film until the teeth are in occlusion. The upper and lower occlusal planes when in centric must be horizontal; the sagittal plane of the face must be perpendicular to this. The bite wing exposure is the only one in which a definite angulation is used, and here in the bicuspid region a plus 10 degree vertical angulation is employed in the average case. If the patient presents a cross-bite or edge-to-edge bite, a plus 12 degree vertical angulation is used. The horizontal angulation is directed so that the rays pass through the contact of the upper and lower first or second bicuspids, whichever teeth are more typically aligned in the arch. In this area the contacts usually run at right angles to the dental ridge. The central beam is directed at the occlusal surfaces in contact. The lip line, or corner of the mouth, is a good general guide.

In the molar region the film should be placed so that:

(1) Mesially nothing farther forward than the distal portions of the second bicuspid appear.

(2) Distally the entire surfaces of the third molars if they are in position.

The film is placed in the mouth in exactly the same manner as was the case for the bicuspid exposure, care being exercised to note that the patient is in tight centric relationship. Because of the usual lingual inclination of the lower molars, a plus 12 degree vertical angulation is used in normal cases and a plus 14 degree angulation if the patient presents a cross-bite or edge-to-edge bite. The horizontal angulation is directed so that the rays pass between the upper first and second molars, usually in a mesial oblique direction. The central beam is directed in the same manner as for the bicuspid projection.

CONCLUSION

There are many types of individuals in the practice of dentistry today. Some are chiefly conscious of the time element involved in each operation; others are chiefly

conscious of the expense involved in various procedures; a few are really conscious of the service they may be able to render their patients. It will be noted that in this technique more exposures are required than in the commonly practiced techniques, and a greater length of time will also be necessary. However, if we are to render a diagnostic service to our patients which will provide us with images of conditions as they actually exist in the mouth, then a technique such as this for making exposures must be standardized and consistently used. Since intra-oral roentgenograms are a vital link in the chain of oral diagnosis the production of the most accurate images upon a dental film is of utmost importance. Most roentgenograms produced in dental offices today do not show these conditions, and consequently are of little value, leading only to faulty diagnosis. When a greater interest and effort is placed upon the type of intra-oral roentgenograms produced then more adequate roentgenograms will result.

Walter G. Zoller Memorial Dental Clinic
950 East 59th St.
Chicago 37, Ill.



THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: MERRILL C. SOSMAN, M.D.

Associate Editor: LAWRENCE REYNOLDS, M.D.

Assistant Editor: RUTH BIGELOW, B.S.

Editorial Board: A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board for Pathology: EUGENE L. OPIE, M.D.

Collaborating Editors: The Officers and Committee Members of the Societies of which this JOURNAL is the official organ, whose names appear on this page, are considered collaborating editors of this JOURNAL. *Foreign*

Collaborators: GÖSTA FORSELL, M.D., STOCKHOLM, R. LEDOUX-LEBARD, M.D., PARIS.

Publisher: CHARLES C THOMAS, 301-327 East Lawrence Avenue, Springfield, Illinois.

Issued Monthly. Subscription \$10.00 per year, \$11.00 in Canada and \$12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich., Office of publication 301-327 East Lawrence Avenue, Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Lawrence Reynolds, Detroit, Mich.;
President-Elect: U. V. Portmann, Cleveland, Ohio;
1st Vice-President: C. M. Richards, San Jose, Calif.;
2nd Vice-President: E. E. Barth, Chicago, Ill.; *Secretary:* H. Dabney Kerr, University Hospital, Iowa City, Iowa; *Treasurer:* Wendell G. Scott, 510 South Kingshighway Blvd., St. Louis 10, Mo.

Executive Council: Lawrence Reynolds, U. V. Portmann, C. M. Richards, E. E. Barth, H. D. Kerr, W. G. Scott, M. C. Sosman, H. G. Reineke, J. T. Case, C. A. Good, R. C. Beeler, J. B. Edwards, P. A. Bishop, M. J. Geyman, H. F. Hare, Chairman, 605 Commonwealth Ave., Boston 15, Mass.

Program Committee: H. D. Kerr, Iowa City, Iowa, M. C. Sosman, Boston, Mass., J. T. Case, Chicago, Ill., C. A. Good, Rochester, Minn., H. F. Hare, Boston, Mass., U. V. Portmann, Chairman, Cleveland Clinic, Cleveland 6, Ohio.

Publication Committee: P. C. Swenson, Philadelphia, Pa., R. J. Reeves, Durham, N. C., J. T. Case, Chairman, Chicago, Ill.

Finance Committee: E. L. Jenkinson, Chicago, Ill., B. R. Young, Philadelphia, Pa., H. G. Reineke, Chairman, Cincinnati, Ohio.

Committee on Scientific Exhibits: R. A. Arens, Chicago, Ill., E. B. D. Neuhauser, Boston, Mass., C. A. Good, Chairman, Rochester, Minn.

Representative on National Research Council: Robert P. Ball, New York, N. Y.

Editor: Merrill C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.

Associate Editor: Lawrence Reynolds, 110 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: Eugene L. Opie.

Fifty-first Annual Meeting: Jefferson Hotel, St. Louis, Mo., Sept. 26-29, 1950.

AMERICAN RADIUM SOCIETY

President: William S. MacComb, New York, N. Y.; *President-Elect:* Leland R. Cowan, Salt Lake City, Utah; *1st Vice-President:* James A. Corscaden, New York, N. Y.; *2nd Vice-President:* Douglas J. Roberts, Hartford, Conn.; *Secretary:* Hugh F. Hare, 605 Commonwealth Ave., Boston, Mass.; *Treasurer:* Howard B. Hunt, University Hospital, Omaha, Nebr.

Executive Committee: Charles L. Martin, Chairman, Dallas, Texas, A. N. Arneson, St. Louis, Mo., Maurice Lenz, New York, N. Y.

Program Committee: Leland R. Cowan, Chairman, Salt Lake City, Utah, Joseph Farrow, New York, N. Y., John L. Pool, New York, N. Y.

Publication Committee: Edward H. Skinner, Chairman, Kansas City, Mo., Simeon T. Cantril, Seattle, Wash., Harry Hauser, Cleveland, Ohio.

Education and Publicity Committee: James A. Corscaden, Chairman, New York, N. Y., John F. Hynes, Wilmington, Del., Grant H. Beckstrand, Los Angeles, Calif.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., G. Failla, New York, N. Y., F. W. O'Brien, Boston, Mass.

Representatives on American Board of Radiology: Douglas Quick, Chairman, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Committee on Arrangements: Gordon P. McNeer, Chairman, New York, N. Y., Gray H. Twombly, New York, N. Y., Theodore R. Miller, New York, N. Y.

Advisory Committee on X-ray and Radium Protection of the National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., John E. Wirth, Baltimore, Md.

Exhibit Committee: Robert E. Fricke, Chairman, Rochester, Minn., William Harris, New York, N. Y., Milton Friedman, New York, N. Y.

Thirty-second Annual Meeting: Biltmore Hotel, New York, N. Y., May 25-26, 1950.

EDITORIALS

IS ROENTGEN THERAPY HAZARDOUS IN BENIGN BONE LESIONS?

DURING recent years several investigators have advanced the theory that roentgen therapy has a certain contributory role in the transformation of benign giant cell tumor of bone into osteogenic sarcoma and that it is therefore a hazardous procedure to use in benign bone lesions. To support this view much emphasis is laid on a series of cases collected from the early literature in which roentgen therapy was given for tuberculous arthritis and in which osteogenic sarcoma developed later within the treated area. Likewise, considerable importance is given to the observation made in conjunction with the radium dial painters in which, as is known, osteogenic sarcoma of one or several bones constituted an infrequent terminal complication of the radium poisoning. Finally, individual cases are cited in which osteogenic sarcoma arose from bones which were in the field of roentgen therapy given for some independent lesion. In this latter group, severe radiation osteitis, due to over-irradiation, usually preceded for long periods the appearance of the sarcomatous transformation.

In discussing the attributed role of roentgen therapy in the sarcomatous conversion of a benign giant cell tumor, it is advisable to consider separately the occurrence of the possible malignant change without roentgen treatment and the effect of the roentgen rays on the bone as part of a routine irradiation.

The idea that giant cell tumor of bone is always benign originated in 1920 when the Registry of Bone Sarcoma coined for its designation the term of "benign giant cell tumor," the purpose being to eliminate the misleading name of "giant cell sarcoma"

which was in vogue at that time. It was soon found, however, that a certain percentage of the giant cell tumors behaved as malignant from the beginning and that others became so later. This observation then has led to the assumption that there must be various causes which are responsible for the malignant transformation. Among these causes an ever increasing role was attributed to the disruptive action of the roentgen rays.

In the November issue of this JOURNAL¹ a study was published in which the various possibilities leading to a malignant degeneration of giant cell tumor of bone were analyzed on the basis of a personal series of the authors and an exhaustive review of the literature was given. The conclusions were reached that a malignant degeneration may be observed to occur: (1) spontaneously, if no treatment was given; (2) following repeated surgery and irradiation with different agents; (3) following roentgen therapy alone, and (4) following surgery alone when bone chips were used to fill the bone cavity. For obvious reasons, the group of cases of spontaneous malignant degeneration is too small to permit an evaluation of its exact incidence. In those cases in which various forms of treatment were used, the incidences were approximately the same. There was no evidence that in the series treated by roentgen therapy alone, or in association with other methods, the incidence of malignant degeneration was higher than if no roentgen therapy was employed. As a whole, it ap-

¹ Leucutia, T., and Cook, J. C., Malignant degeneration of benign giant cell tumor of bone. *AM. J. ROENTGENOL. & RAD. THERAPY*, November, 1949, 62, 685-706.

peared that malignant degeneration of giant cell tumor of bone constitutes a phase in the natural sequence of events unaffected by the type of treatment given. The number of cases in which such malignant degeneration occurs is given as varying between 8 and 15 per cent.

The situation is somewhat similar to that observed in osteochondroma, where likewise a malignant degeneration is often found after long periods of quiescence and apparently without any demonstrable cause. In fact, it may be said that every benign tumor has its malignant counterpart, the time and frequency of the metaplasia depending on the individual characteristics of the tumor. A sarcomatous transformation is even noted in some of the more generalized diseases or anomalies of the osseous skeleton, as, for example, in hereditary chondrodysplasia, in fibrous dysplasia of bone, in myositis ossificans and osteitis fibrosa cystica. Above the age of fifty, Paget's disease is the most important contributory cause in a large percentage of the osteogenic sarcomas. It is highly improbable that the administration of roentgen therapy would have a tendency to further increase the incidence of malignant transformation in any of these conditions.

The effect of roentgen rays on bone depends, as in any other structure, on the amount given. A sharp distinction must be made between those cases which were grossly over-irradiated and those which received the customary therapeutic dose.

The observation that grossly over-irradiated tissue finally undergoes malignant neoplasia is as old as the science of radiology. If the action of the roentgen rays is confined mostly to the surface layers of the body, the changes occur primarily in the skin, eventually culminating in carcinoma. If the effect is deeper, changes may also be observed in the connective tissue elements resulting in sarcoma of the soft parts or bone. The ratio of carcinoma and sarcoma induced by roentgen rays is approximately ten to one. If the irradiation is internal, as, for example, in the case of the radium dial

painters, and an irreversible deposition of the radioactive material occurs in the bone, osteosarcoma develops in a large majority of the cases. It is of fundamental importance, however, that in all these instances severe alterations of the tissues precede for years the malignant metaplasia. Marked atrophy of the skin, telangiectasis, ulceration, secondary infection, chronic osteitis, progressive bone absorption and other similar structural changes are nearly always present in one form or another. It is of no particular significance whether these alterations have been produced by a large single dose or by small doses repeated at shorter or longer intervals or by minimal doses acting continuously over a long period of time, as in the case of radium. Once the tissues have been severely damaged, no measure known at the present time can be used to preclude the eventual malignant transformation which follows in an impressive number of cases. The great majority of the radiation induced osteogenic sarcomas reported in the literature and all the osteosarcomas observed in the radium dial painters are the result of such over-irradiation.

In the ordinary roentgen treatment of giant cell tumor of bone and some of the allied conditions the required dose is considerably smaller. Permanent functional and anatomic results can be obtained with hardly any skin change being noticeable in later life. There is no evidence that under such conditions roentgen therapy constitutes a greater hazard in lesions of the bone than of any other structures. The increased ionization resulting from the somewhat greater absorption of the roentgen rays in the bone is an asset rather than a liability, permitting a slightly more efficient irradiation. This factor cannot be made responsible for any sarcomatous induction or conversion. It is more likely that osteogenic sarcomas which develop in giant cell tumors treated by roentgen therapy or arise after many years at the sites of giant cell tumors apparently cured by ordinary doses of roentgen rays represent samples of malig-

nant neoplasia occurring during the natural sequence of events. This view is supported by the fact that one hardly ever sees an osteogenic sarcoma develop in the massive bones of the pelvic girdle when radiation therapy is given for carcinoma of the cervix or some other intrapelvic lesion although the doses are considerably larger than those used in the benign tumors of bone.

It may be concluded from the above that roentgen therapy with ordinary doses is a safe procedure for the treatment of

benign lesions of bone. The malignant transformation which is observed in a certain percentage of cases cannot be attributed to a direct cancerogenic effect of the roentgen rays, but is an occurrence in the natural sequence of events or represents a sequela of severe tissue damage produced by gross over-irradiation. This observation does not apply to internal irradiation with radioactive isotopes some of which possess, by their chemical nature, direct cancerogenic properties.



JOHN REMER

1862-1949

DR. JOHN REMER, of Charlotte, North Carolina, died on September 28, 1949, of a bronchogenic carcinoma in the right upper lobe.

John Remer was born October 21, 1862, in San Francisco, the son of Simeon Remer and Mary Farrell Remer. He received the degree of A.B. in 1886 and A.M. in 1889,



John Remer

both from Allegheny College. In 1890 he received his M.D. from the College of Physicians and Surgeons, Columbia University. He spent twenty-one years in general practice in New York City, and delivered some twelve hundred infants, before he specialized in radiology. His first published paper was in 1912, "The X-ray in General Dentistry." He soon found radiation therapy of more interest than diag-

nostic roentgenology, and he became associated with Dr. George M. MacKee. From dermatologic therapy he soon went on to the use of all types of radiation therapy. During World War I, he taught roentgen therapy in the school which the Army established in New York. He was co-author with Dr. W. D. Witherbee of a book "X-ray Dosage in Treatment," published in 1923 by Macmillan.

Dr. Remer was in charge of therapy or (later) consultant at New York Hospital for thirty-five years. He served on the staffs also of Vanderbilt Clinic, Harlem, Fordham, Gouverneur, St. Clare's, and Port Chester Hospitals. He was a fellow of the American Medical Association, of the New York Academy of Medicine, and of the American College of Radiology. He was a life member of the American Roentgen Ray Society, a member of the Radiological Society of North America, and of the New York Roentgen Society; and an honorary member of the Canadian Radiological Society.

In 1922 he was married to Miss Marie Donaldson, of New York, who survives him. He was a 32d degree Mason, and a life member of Harlem Lodge. He was a member of Theta Delta Chi and of the Columbia Club.

Dr. Remer practiced his profession until he was eighty-two. At the time of his retirement, some of his New York colleagues held a farewell party for him, in the old Murray Hill Hotel. He and Mrs. Remer first tried Sarasota, Florida, but found the summers too hot and the sunlight too bright for comfort. The more temperate climate of North Carolina was more to their liking. To a remarkable degree, John Remer fulfilled the old axiom "To win friends, show yourself friendly." When I last saw him, the day before his death, he was still the same winsome character who had won the love of all who knew him. ROBERT H. LAFFERTY, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. Barton R. Young, 3401 North Broad St., Philadelphia, Pa. Annual meeting: Jefferson Hotel, St. Louis, Mo., Sept. 26-29, 1950.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Biltmore Hotel, New York, N. Y., May 25-26, 1950.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Cleveland Auditorium and Statler Hotel, Cleveland, Ohio, Dec. 4-9, 1949.

AMERICAN COLLEGE OF RADIOLOGY

Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1950, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill. Annual Meeting: 1950, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS

Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY

Secretary, D. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. through April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the University Club.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY

Secretary, Dr. Paul E. RePass, 306 Republic Bldg.,

Denver 2, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY

Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

GREATER MIAMI RADIOLOGICAL SOCIETY

Secretary, Dr. David Kirsh, 712 duPont Bldg., Miami 32, Florida. Meets last Wednesday of each month at 8:00 P.M. at Veterans Administration Regional Office.

HOUSTON X-RAY CLUB

Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. William M. Lochr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY

Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

* Secretaries of societies are requested to send timely information promptly to the Editor.

LOUISVILLE RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minn. State Med. Assn., the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Harvard Club.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. F. H. Ghiselin, 111 East 76th St., New York 21, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

Secretary, Dr. R. L. Ayers, 726 4th St., Marysville, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY

Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY

Secretary, Dr. Selma Hyman, Univ. of Oregon Medical School, Portland, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. G. P. Keefer, 1930 Chestnut St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. E. J. Euphrat, 3500 Fifth Ave., Pittsburgh

13, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY

Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, Sept. to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY

Secretary, Dr. K. C. Corley, 1835 Eye St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, Jan., March, May, Oct. at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. Benjamin Copleman, 280 Hobart St., Perth Amboy, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo. August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston first Thursday in November, also with South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

CUBA**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO**SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA**

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS

Honorary Secretary, Dr. J. F. Fromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGISTS

Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.

Honorary Secretaries, State Branches:

New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.

Victoria, Dr. T. I. Tyrer, 3 Lockerbie Court, East St. Kilda.

Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.

South Australia, Dr. R. de G. Burnard, 170 North Terrace, Adelaide.

Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.

New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

SOUTH AMERICA**SOCIEDAD ARGENTINA DE RADIOLOGIA**

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGÍA, FILIAL DEL LITORAL

President, Dr. Francisco P. Cifarelli. Meets second

Wednesday each month, at 7:00 P.M., at 663 Italia St. in Rosario.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA

Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA

Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

Secretary, Dr. Arias Bellini.

CONTINENTAL EUROPE**SOCIÉTÉ BELGE DE RADIOLOGIE**

General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

ČESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ SUISSE DE RADIOLOGIE)

President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA

Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

DEPTH DOSE DATA FOR RADIATION FROM 22 MEV. BETATRON

To the Editor:

H. E. Johns *et al.*¹ have recently published measurements of depth dose in a water phantom using 22 mev. betatron radiation filtered by a conical copper plug shaped to compensate for the normal angular distribution of the roentgen radiation and produce a uniform intensity over a selected field. We have read this article with a great deal of interest and it appears to be the result of considerable careful experimental work.

There is one statement in their article on page 262 in reference to the work of Charlton and Breed² with which we are not in agreement because it indicates a misinterpretation of the technical data. They state that the actual peak percentage depth dose they obtain at 22 mev. occurs at a considerably greater depth than that obtained by Charlton and Breed at 20 mev. Their statement should be further clarified to point out the essential difference between the two sets of measurements to which they refer. In the particular data in our article to which they refer, the maximum depth dose at 20 mev. occurred at 1.5 cm. in a pressboard phantom with unfiltered radiation. These particular depth dose data were taken with unfiltered radiation in order to cover with a single technique the voltage range from 20 to 100 mev. over most of which filtration gives only a slight advantage. On pp. 172-174 of the Charlton and Breed article there appears a discussion of the use of filters and curves shown that were taken with filtered radiation. This is the 20 mev. depth dose data that should be compared with the Johns *et al.* 22 mev. measurements. A comparison of these data makes it apparent that at 20 mev. there is excellent agreement between the two sets of data, particularly

when it is remembered that our curves were obtained using a flat copper filter 1 cm. thick while the curves of Johns *et al.* were obtained with a compensating copper filter of apparently about 3 cm. maximum thickness. It is also interesting that the depth dose agreement is so close when one considers the fact that the results were obtained with two entirely different machines and by very different measuring techniques.

E. E. CHARLTON

Research Laboratory
General Electric Co.
Schenectady, N. Y.

RADIOISOTOPE TECHNIQUES COURSES

Some vacancies still remain for the winter series of three Radioisotope Techniques Courses offered by the Special Training Division of the Oak Ridge Institute of Nuclear Studies.

Interested persons who can attend a course during the winter months are urged to make application for one of these courses in view of the heavy load of applications from university people for participation in the summer courses. The courses will begin on January 2, January 30, and March 6, 1950. Applications should be made as soon as possible. Requests for application and additional information should be addressed to Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

The courses are offered at Oak Ridge to acquaint research workers with the safe and efficient use of radioisotopes as tracers. Emphasis is placed on individual laboratory work, with sufficient lecture material included to provide the necessary background information. Eleven of the courses already have been given. Thirty-two participants can be accommodated in each of the three four-week courses.

GREATER MIAMI RADIOLOGICAL SOCIETY

The radiologists of the Greater Miami area, after meeting at monthly intervals informally for a period of about two years,

¹ Johns, H. E., Darby, E. K., Haslam, R. N. H., Katz, L., Harrington, E. L. Depth dose data and isodose distributions for radiation from a 22 mev. betatron. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1949, 62, 257-268.

² Charlton, E. E., and Breed, H. E. Some depth dose studies of roentgen rays for energy levels from 20 to 100 million electron volts. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1948, 60, 158-174.

organized at a meeting held on October 26, 1949. The name, Greater Miami Radiological Society, was adopted and the following officers were elected: *President*, Dr. Gerard Raap; *Secretary*, Dr. David Kirsh. Meetings are held on the last Wednesday of the month throughout the year at 8:00 P.M. at the Veterans Administration Regional Office, 3300 N.E. Second Avenue, Miami, Florida.

CINCINNATI RADIOLOGICAL SOCIETY

The first annual meeting of the Cincinnati Radiological Society was held on Monday, October 17, 1949, and the following officers were elected for the coming year: *President*, Dr. Maurice R. Walsh; *Secretary*, Dr. E. C. Elsey.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

The officers of the Northern California

Radiological Club for the year 1949-1950 are as follows: *President*, Dr. George Hemminger, Sacramento, California; *Secretary*, Dr. Robert L. Ayers, Marysville, California.

OREGON RADIOLOGICAL SOCIETY

At a recent meeting of the Oregon Radiological Society the following officers were elected for the coming year: *President*, Dr. Sherman E. Reese; *Vice-President*, Dr. G. B. Isenhardt; *Secretary-Treasurer*, Dr. Selma Hyman.

PITTSBURGH ROENTGEN SOCIETY

At the meeting of the Pittsburgh Roentgen Society held on October 12, 1949, the following officers were elected for the coming year: *President*, Dr. R. Paul Meader; *Vice-President*, Dr. Eva S. Carey; *Secretary-Treasurer*, Dr. Edwin J. Euphrat.



ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W.,
Washington 6, D. C.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

- BUCKLEY, R. W., and YAKOVLEV, P. I.: Dysostosis of skull, face and extremities (acrocephalosyndactyly)..... 901
- KELEMAN, G., and HOLMES, E. M.: Cavernous haemangioma of the frontal bone..... 901
- MITCHELL, J. F. O., and ASTLEY, R.: Radiology of the temporal bone..... 901
- WELIN, S.: Roentgen ray examination of the paranasal sinuses with particular reference to the frontal sinuses..... 902
- VERMUND, H.: Relation of hypophysis to carbohydrate and basal metabolism..... 902
- PENNYBACKER, J., and RUSSELL, DOROTHY S.: Necrosis of the brain due to radiation therapy..... 902
- SAVITSKY, E., and SPINELLI, V. A.: Agenesis of corpus callosum in infancy..... 903
- MATHIS, W. H., JR., and SCHULZ, M. D.: Roentgen diagnosis of glomus tumors.... 903
- COSTERO, J.: Some problems related to the origin and meaning of pituitary gland tumors..... 903
- EVANS, W. G., and PICCIOTO, G.: Chromophobe adenoma of the pituitary..... 904

Neck and Chest

- SIMPSON, J. F., and HILTON, GWEN: Malignant disease of the pharynx, excluding the nasopharynx..... 904
- CLARK, J. V.: Case of submucous abscess of the oesophagus..... 904
- LOHMAN, A. J. M.: Mediastinitis anterior chronica..... 905
- FLEISCHNER, F. G., BERNSTEIN, C., and LEVINE, B. E.: Retrosternal infiltration in malignant lymphoma..... 905
- KERLEY, P.: Chronic diseases of the pericardium..... 905
- PULCHERIO, J. B., JR.: Mitral stenosis..... 905
- MORTENSEN, V., and WARBURG, E.: Chronic constrictive pericarditis..... 905
- POTTER, B. P., and GERBER, I. E.: Acute diffuse interstitial fibrosis of the lungs.... 906
- BARDEN, R. P., and COOPER, D. A.: Roentgen appearance of the chest in diseases affecting the peripheral vascular system of the lungs..... 906

- POTTS, W. J., and GIBSON, S.: Aortic pulmonary anastomosis in congenital pulmonary stenosis..... 907
- MACLEAN, K. S.: Relation of idiopathic pleurisy and pleural effusion to tuberculosis..... 908
- GOODRICH, W. A.: Pulmonary edema..... 909

Abdomen

- GREENWOOD, F., and SAMUEL, E.: Pathological gallbladder..... 909
- HUGHES, C. R., HANNAN, J. R., and MULVEY, B. E.: Cholangiography in stone stricture and operative injury of biliary ducts.. 910
- GOIN, L. S.: Fibrocystic disease of the pancreas..... 910
- SELMAN, J., and BENDER, J. R.: Mesenteric lipoma in a child..... 910
- LIKELY, S. D., *et al.*: Primary malignant disease of the small bowel..... 911
- WELLS, JOSEPHINE: Mucosal pattern of the terminal ileum in children..... 911
- PENDERGRASS, R. C.: Extrinsic deformities of the colon..... 911
- BELL, J. C., and DOUGLAS, J. B.: Roentgen-ray diagnosis of malignant and potentially malignant lesions of the colon and rectum..... 911

Skeletal System

- PETERMAN, M. G., FREY, W. B., and KASTER, J. D.: Value of routine roentgenograms of the wrist in a pediatric service..... 912
- STEINBERG, C. L.: Brucellosis as a cause of sacro-iliac arthritis..... 912
- MARÓTTOLI, O. R.: General concept of pseudarthrosis..... 912
- CASSIDY, W. J., ALLMAN, F. C., and KEEFE, G. J.: Osteopetrosis..... 913
- RATHBURN, J. C.: Hypophosphatasia..... 913
- LAPIDUS, P. W., *et al.*: Eosinophilic granuloma of bone..... 914

General

- ARDRAN, G. M.: Armillifer armillatus..... 914
- BLANCHARD, A. J., and BOONE, F. H.: Reticulo-endothelial granulomatosis..... 915
- LINDSAY, S., *et al.*: Gargoylism. II. Study of pathologic lesions and clinical review of twelve cases..... 916

ROENTGEN AND RADIUM THERAPY

- GOLDMAN, R., *et al.*: Clinical experience with nitrogen mustard therapy..... 916
- SNAPPER, I.: Treatment of multiple myeloma with stilbamidine..... 917
- KELLY, J. F., DOWELL, D. A., and DOWNING, J. E.: Roentgen rays in prevention and treatment of infections..... 917
- RIEBELING, M.: Roentgen treatment of ex-

- ternal infections due to bacillus anthracis..... 917
- BODEN, G.: Radiation myelitis of the cervical spinal cord..... 917
- SCHENCK, S. G.: Radiation therapy for Wilms' tumor of the kidney..... 918
- ARNESON, A. N., STANBRO, W. W., and NOLAN, J. F.: Use of multiple sources of radium within the uterus in the treatment of endometrial cancer..... 918

ROENTGEN DIAGNOSIS

HEAD

- BUCKLEY, ROBERT W., and YAKOVLEV, PAUL I. Dysostosis of skull, face and extremities (acrocephalosyndactyly). *Am. J. Dis. Child.*, May, 1948, 75, 688-695.

In connection with the study of a recently observed case of acrocephaly, facial deformities and syndactylism, with mental deficiency, the authors reviewed the literature pertaining to clinical descriptions of similar cases. The survey of the literature revealed numerous cases in which different features of their case were present in several combinations. Their patient's set of physical and mental anomalies would appear to represent a complete picture, parts of which have been reported under various clinical names and personal eponyms.

The roentgenograms of the patient, a boy of twelve, showed in the skull, a high crested appearance of the calvarium, the characteristic "lacunar" defects in the frontal region, shallow orbits, dental anomalies and prognathism. The spinous processes of the fifth and sixth cervical vertebrae were apparently fused. The head of the right humerus was translucent with a thin cortex and expanded and deformed outline. It appeared to be fused to the glenoid process of the scapula, with radiating dense bony spicules continuous with similar structures on the blade of the scapula. The distal extremity of the humerus showed normal density and persistent epiphyseal separation, the shaft being short and bowed. Posteroanterior views of both feet showed condensation of the phalanges of each digit, with preservation of the proximal epiphyses, but only indistinct separation distally. The first and second metatarsals were grossly deformed bilaterally. The left second metatarsal was angulated laterally with local density suggestive of old fracture, and the right first and second metatarsal were united by a broad, bony band with anomalous articulation of the

first on the ankle. Roentgenograms of the left shoulder and hands showed analogous deformities.

The authors express the opinion that "Apert's disease," or acrocephalosyndactylism, and "Crouzon's disease," or craniofacial dysostosis, are both manifestations of the same pathologic process. The condition of faulty bone development and articulation is believed to be due to a germ-plasm defect influencing the growth of both "membranous" and "cartilaginous" bone.—R. S. Bromer, M.D.

- KELEMAN, GEORGE, and HOLMES, EDGAR M. Cavernous haemangioma of the frontal bone. *J. Laryng. & Otol.*, Sept., 1948, 62, 557-563.

The authors state that only 2 cases of cavernous hemangioma limited to the frontal bone have been reported and theirs is the third. They describe the characteristic "sunburst" pattern with trabeculations which radiate from a common center and mostly in the plane of the bone. Sometimes there are additional perpendicular striations or radiating spicules which are identical with those of an osteogenic sarcoma. In these cases an accurate diagnosis can be made only by histopathological examination.

They report a case in which repeated trauma is a factor and may have contributed to the progress of the lesion. They stress complete removal of both tables of the skull and a small surrounding area of normal bone to assure a complete cure. Recurrences after incomplete removal are common.—F. M. Windrow, M.D.

- MITCHELL, J. F. O., and ASTLEY, ROY. Radiology of the temporal bone. *J. Laryng. & Otol.*, Sept., 1948, 62, 564-567.

The authors present 14 good roentgenograms of a disarticulated temporal bone in the various usual projections. Wire markers outline the external and internal auditory meati, the eustachian tube and the facial nerve. Thin lead foil

is used to outline the sigmoid sinus groove and the mastoid antrum. The reproductions of the roentgenograms offer a good review of the roentgen anatomy of the temporal bone.—*F. M. Windrow, M.D.*

WELIN, SOELVE. The roentgen ray examination of the paranasal sinuses with particular reference to the frontal sinuses. *Brit. J. Radiol.*, Sept., 1948, 21, 431-437.

The routine examination of the paranasal sinuses as carried out by the author consists of six projections. The direct posteroanterior view is made with the film angled 30 degrees from the vertical and with the patient's forehead against the film. A second posteroanterior view is made with the film tilted slightly less and with the nose and open mouth against the film. A direct lateral view is made. Two submentovertical views are made, one exaggerated so that the mandible is projected anterior to the frontal sinuses. This view permits visualization of the depth of the frontal cells, both medially and laterally, and shows well the thickness of the walls. These five views are all made with the patient upright. In this way fluid levels are usually shown, but at times the extent and location of fluid are better shown in the sixth view made in a posteroanterior projection with the patient horizontal and with either right or left side down. This also shows small amounts of fluid which might be invisible by other methods. Air trapped in hyperplastic or edematous mucosal folds has been demonstrated in this way.—*E. F. Lang, M.D.*

VERMUND, HALVOR. The relation of hypophysis to carbohydrate and basal metabolism. *Acta med. Scandinav.*, April, 1948, 131, 515-546.

Report is made of a case in which the patient, a female, aged forty-six, had signs of acromegaly. Roentgenograms revealed a tumor of the pituitary. Three months before her hospital admission she developed symptoms of diabetes mellitus, and on examination in the hospital she had considerable acidosis with imminent coma. She recovered under therapy. Then on the twelfth day after admission, signs of hypoglycemia suddenly appeared. Insulin and dietary restrictions were withdrawn, and after this time there was no hyperglycemia and no glucosuria. The glucose tolerance test became normal, though previously diabetic in nature, and the diabetes was considered cured. Hypothyroid

symptoms developed, necessitating use of thyroid extract. The signs of acromegaly regressed, and the patient has since been in good health and quite fit for work.

It is postulated that increased pituitary function led to acromegaly, and probably to the adverse carbohydrate change. Hyperfunction was followed by hypofunction, with regression of the acromegaly, depression of thyroid function and disappearance of the diabetogenic and insulin-antagonistic effects.—*Charles Nice, M.D.*

PENNYBACKER, JOE, and RUSSELL, DOROTHY S. Necrosis of the brain due to radiation therapy; clinical and pathological observations. *J. Neurol., Neurosurg. & Psychiat.*, Aug., 1948, 11, 183-198.

The authors report the clinical and pathological features of 5 cases of necrosis of the brain following radiation therapy, these cases having been treated in different centers with accepted techniques and dosages.

The smallest dose utilized was 2,300 r in a single exposure to a basal cell carcinoma of the scalp (230 kv., 10 ma., half-value layer 1.3 mm. Cu, focal skin distance 29 cm., 7 cm. in diameter) and 4,800 mg-hr. of radium implantation (begun after neurological signs had already appeared). Large dosage was used in a spongioblastoma multiforme which received 44,400 mg-hr. at 4 cm. distance in 1935, through nine fields and then remained asymptomatic until 1941. In March, 1942, she received 9,900 r through five fields. She died in July, 1942, with no residual tumor at postmortem, but with extensive radiation degeneration.

The clinical effects may come on suddenly, progress to a point and become arrested; or they may come on gradually and lead to death. In each case, there was a long latent period between the radiation treatment and the onset of clinical signs of necrosis. The shortest interval was nine months, the longest five years.

The pathology of the necrosis appears to be related to reactions in the smaller blood vessels (perforating) in which collagenous thickening, fibrinoid necrosis and thrombosis are conspicuous.

As it seems impossible to predict in which cases necrosis will occur, it is suggested that irradiation should be reserved for inoperable tumors and those cases in which no further surgical procedures are contemplated.

The authors stress that these changes are not a contraindication to radiation therapy especially since the combination of surgery and irradiation resulted in the remarkable survival of over seven years in the spongioblastoma multiforme case quoted above.—*Herbert Lobenz, M.D.*

SAVITSKY, ELIAS, and SPINELLI, VINCENT A. Agnesis of corpus callosum in infancy; clinical and roentgenologic aspects. *Am. J. Dis. Child.*, July, 1948, 76, 109-115.

The case reported in this paper is the eleventh in which postmortem diagnosis and necropsy studies have been correlated. Their patient and that reported by Reeves are the youngest patients for whom the diagnosis of agnesis of the corpus callosum was made by air studies. Associated anomalies in this case were fetal arrangement of the medial sulci, microgyria, polygyria, heterotopia, internal hydrocephalus and granular ependyma.

The clinical picture of agnesis of the corpus callosum is nonspecific, since it probably depends on the pathologic disturbances that co-exist with the condition, which vary from case to case.

The authors consider the combination of roentgenologic signs described by Davidoff and Dyke as diagnostic. These are:

1. Lateral ventricles are widely separated.
2. Dorsal margins of lateral ventricles are pointed or angular rather than flat.
3. Medial borders of lateral ventricles are concave.
4. Caudal portions of later ventricles are dilated.
5. Interventricular foramens are elongated.
6. The third ventricle is dilated and extends dorsally beyond the normal limits.
7. Air shadows cast by sulci on medial aspects of cerebral hemispheres show radial arrangement of sulci and their extension through the zone normally occupied by the corpus callosum.

The authors also quote Penfield and Hyndman who considered the bicornuate appearance of the bodies of the lateral ventricles as pathognomonic of the condition.—*R. S. Bromer, M.D.*

MATHIS, WILLIAM H., JR., and SCHULZ, MILFORD D. Roentgen diagnosis of glomus tumors. *Radiology*, July, 1948, 51, 71-76.

Tumors of the subcutaneous neuromyo-

arterial plexus, the glomus body, occur once in 32,000 hospital admissions, and once in 4,500 surgical specimens at the Massachusetts General Hospital. The glomus is a minute specialized body which is supposed to serve as a temperature regulating mechanism by causing blood flow in response to certain stimuli. These bodies are located in the subcutaneous layer of the skin, and range from ten to five hundred per square centimeter. They are most numerous in the nail beds, the tips of the palmar surfaces of the digits, and the soles of the feet.

Clinically, glomus tumors are subcutaneous nodules which, when given such stimuli as cold or trauma, precipitate severe paroxysms of pain. When located sublingually they may cause elevation or deformity of the nail.

Erosion of the bone of the distal phalanx with a smooth concave defect is shown to be typical roentgen picture of glomus tumor.

Treatment is simple excision of benign tumor.—*Richard E. Kinzer, M.D.*

COSTERO, J. Some problems related to the origin and meaning of pituitary gland tumors. *Arch. Path.*, Sept., 1948, 46, 243-259.

Based upon a study of 150 tumors of the pituitary gland this paper emphasizes the multipotentiality of the pituitary anlage and discusses the proper classification of various pituitary tumors on the basis of their morphology and their probable relationship to the cell types of the embryonic pituitary.

The author feels that "oligochromic adenomas" are acidophilic adenomas which have lost some of their power to elaborate specific granules. He considers the so-called pregnancy adenomas of Poindecker and transitional adenomas of Kraus to be intermediate between acidophilic and oligochromic adenomas.

The various morphologic types of chromophobe adenomas are described and illustrated. The author considers them to be a true group with a common origin, attributing the great variation in their histopathological appearance to the multipotentiality of the cells. He feels that suprasellar cysts are simply persistent embryonic vesicles and proposes the name "archeoblastoma." Pituitary adamantinomas are rare and only those epithelial tumors producing calcifiable hyaline substance should be considered true adamantinomas.

Costero feels that true teratomas are also rare in the pituitary and that most so-called

teratomas show predominance of one structure and should be classified as hamartoma or choristoma.—*David D. Beiler, M.D.*

EVANS, W. G., and PICCIOTO, G. Chromophobe adenoma of the pituitary. *Brit. J. Radiol.*, July, 1948, 21, 330-336.

Except for the few cases when a chromophobe adenoma is suprasellar, the first symptoms are caused by pressure on the pituitary itself: amenorrhea in the female and loss of libido in the male. Headaches are variable, but a constant finding at some time or other in the course of the disease is sellar erosion. Almost all patients suffer from pressure on the optic chiasm. Hemianopsia and scotoma are frequent: blindness or normal vision is rare. The course of the disease is usually progressive, with possible periods of arrest, and hypophyseal cachexia or blindness frequently results.

Surgical treatment can improve visual symptoms in 60 per cent and arrest their progress in most of the remainder, but the endocrine abnormality is usually permanent. Postoperative irradiation apparently improves the five year results.

One advantage of surgical treatment is the fact that it permits a histopathological diagnosis. When roentgen radiation alone is used, the following conditions must be excluded as far as possible: tumors at a distance from the sella turcica, craniopharyngiomas, intracranial aneurysms, meningiomas of the tuberculum sellae, malignant nasopharyngeal tumors with involvement of the basisphenoid, primary and metastatic tumors of the pituitary, and glioma of the optic chiasm. In the overwhelming majority of cases an accurate diagnosis can be made without biopsy.

Radiotherapy can be effective, but it must be given in sufficient doses. It is not effective in tumors which have become cystic; on the other hand, if improvement in the perimetric examination does not occur, the therapy has not led to a significant delay. Roentgen therapy usually produces no undesirable secondary effects, even with adequate dosage.—*E. F. Lang, M.D.*

NECK AND CHEST

SIMPSON, J. F., and HILTON, GWEN. Malignant disease of the pharynx, excluding the nasopharynx. *Proc. Roy. Soc. Med.*, July, 1948, 41, 443-448.

Simpson cites two series of laryngopharyngeal cancers reporting five year survival rates of 4 and 5 per cent. Symptoms usually were insidious and most patients presented themselves in an advanced stage.

Histopathology, site of occurrence and operability determine mode of therapy which must be individualized for each case. Cancers involving the vallecula, epiglottis, and aryepiglottic fold respond well to irradiation. Growths involving the pharyngeal wall, pyriform fossa and the post-cricoid region are less susceptible to irradiation and should be resected if feasible. Any carcinoma thought to have invaded the laryngeal cartilage should be resected if possible.

Hilton reports 88 pharyngeal growths. The average duration of symptoms was six months before treatment. The greatest age incidence was 50-80 years with more males presenting. A surgical-radiotherapy team saw each case to determine therapy. All inoperable cases and lymphomas were treated by irradiation only. Local sepsis must be controlled before beginning irradiation. Seventy-one cases received full courses of irradiation; 15 are now alive with an average duration of life of 36.6 months. The others survived an average of 18.4 months.—*Donald R. Bernhardt, M.D.*

CLARK, J. V. A case of submucous abscess of the oesophagus. *J. Laryng. & Otol.*, July, 1948, 62, 461-464.

A twenty-four year old British soldier in India developed a sore throat which was diagnosed as tonsillitis. This subsided in three days, but the patient then complained of severe dysphagia, being unable to swallow solids at all. A barium swallow demonstrated a typical benign stricture which did not relax even after a week of intensive belladonna therapy. The stricture involved the lower third of the esophagus. Esophagoscopy demonstrated a thick yellow membrane in this area. When this was peeled out 15 cc. of pus drained from the area. It was thought that the abscess was within the walls of the esophagus.

A true stricture then developed which was dilated in the usual manner, and the patient sent home with a size 14 bougie to be used regularly. A barium swallow showed the esophagus to be normal at this time with normal peristaltic waves in the involved area.—*F. M. Windrow, M.D.*

LOHMAN, A. J. M. Mediastinitis anterior chronica. *Acta med. Scandinav.*, Jan., 1948, 131, 51-65.

Five cases of precordial complaints are described in which a chronic inflammation of the mediastinum (anterior) with an extensive adhesive formation of the visceral pericardium at the back of the sternum and xyphoid must be considered as the cause of the complaints. The origin is probably connected with a preceding acute tracheobronchitis or pharyngitis. The infecting organism was thought to be a streptococcus or influenza bacillus. The retrograde transport of the organism along the lymph nodes and lymph vessels of the anterior mediastinum is considered the most likely mode of infection. Surgical intervention is the treatment of choice for some cases. One patient was treated by resection of the lower part of the sternum and the xiphoid process. In roentgen diagnosis the lateral film of the chest is of great value. Tomography and kymography may be of value at times.—*Charles Nice, M.D.*

FLEISCHNER, FELIX G., BERNSTEIN, CHARLES, and LEVINE, BERNARD E. Retrosternal infiltration in malignant lymphoma. *Radiology*, Sept., 1948, 51, 350-358.

In the authors' cases of intrathoracic malignant lymphoma, they have occasionally observed retrosternal infiltration, occurring alone or in conjunction with one or several of the usually noted localizations of lymphoma, but not previously described as such.

In a straight lateral view of the chest they distinguish two types of retrosternal infiltration:

(1) A soft tissue mass of even width, 0.5 to 2.0 cm. thick, extending from the level of the diaphragm to the level of the sternoclavicular joint, where it merges with normal soft tissue structures. It apparently represents a lymphomatous mass.

(2) A pad-like mass or several masses giving a lobulated appearance, of similar thickness, convex posteriorly with the base toward the sternum. Possibly this is the early stage of type 1.

Presternal edema was frequently associated, and in one case was the factor leading to search for retrosternal involvement.

The differential diagnosis includes accumulation of fatty tissue, pleural thickening, and inflammatory or neoplastic disease originating in the anterior chest wall structures, whether

soft tissue or skeletal, primary or metastatic.—*Arthur A. Brewer, M.D.*

KERLEY, PETER. Chronic diseases of the pericardium. *Proc. Roy. Soc. Med.*, July, 1948, 41, 437-442.

The roentgen findings in gross pericardial disease are irregularity of the cardiac border, diminished or absent pulsation, limited diaphragmatic movements and associated pleural thickening. Pericardial adhesions most often affect the right heart border and the anterior surface. The most consistent aberration of cardiac silhouette in constrictive pericarditis is a continuously convex right border from diaphragm to aorta. Other less frequent contours are described. Usually the heart is central in position and is small although it may appear enlarged. The retrosternal and retrocardiac spaces may be obliterated and fixation of the heart may be noted, particularly during forced respiration in the lateral recumbent position. Pulsation may be increased or diminished in amplitude. Pericardial calcification is diagnostic of pericardial disease.

Kymographic studies are often diagnostic. Routine examination should include postero-anterior and lateral films taken in the recumbent position.—*Donald R. Bernhardt, M.D.*

PULCHERIO, J. B., JR. Estenose mitral. (Mitral stenosis.) *Brasil méd-cir.*, March, 1948, 10, 151-164.

The author describes in detail the roentgen appearance of mitral stenosis and its complications. Kymographic studies are added in some cases and the roentgenograms are supplemented by line drawings.—*Ernst Schmidt, M.D.*

MORTENSEN, VAGN, and WARBURG, ERIK. Chronic constrictive pericarditis. *Acta med. Scandinav.*, March, 1948, 131, 203-225.

A brief survey is given of the literature on chronic constrictive pericarditis, together with an account of a patient material comprising 25 clear-cut and typical cases besides 8 uncertain or complicated cases.

Clinical symptoms and electrocardiographic changes are discussed. Dyspnea, increasing circumference of the abdomen and tendency to edema were noted most frequently. Venous pressure was usually increased. The liver was consistently enlarged. A protodiastolic rhythm

(pericardial click) was often present. Electrocardiographic changes include flattening or inversion of the T waves in the limb leads.

On roentgenography the heart was of normal size in 18 cases, slightly enlarged in 2 and considerably enlarged in 5. In 12 patients areas of calcification were noted in the pericardium. Enlargement of the heart, pericardial calcification and perpetual arrhythmia tend to accompany each other. Kymography was performed in 18 cases and showed invariably small deflections or none at all. In 7 cases kymography was performed after operation, and in 3 of these cases there was no change in the picture, while in 2 cases the deflection became larger and in 2 cases the kymogram became normal.

Concerning etiology it is doubtful whether rheumatic infection plays any particular role. Tuberculosis, coronary occlusion and trauma apparently are etiological agents although, on the whole, we know very little about the etiology.

In cardiac insufficiency with pronounced edema in relatively young persons, in whom no diagnosis of the heart lesion seems obvious, we should always keep in mind the possibility of chronic constrictive pericarditis.—*Charles M. Nice, M.D.*

POTTER, BENJAMIN P., and GERBER, ISADORE E. Acute diffuse interstitial fibrosis of the lungs. *Arch. Int. Med.*, August, 1948, 82, 113-124.

Both clinicians and pathologists encounter cases of diffuse pulmonary fibrosis of undetermined origin. Generally, these cases are characterized by a protracted clinical course without distinctive features. The postmortem examination usually reveals a non-specific chronic inflammatory process with extensive organization of the alveolar structures.

The paucity of pulmonary signs on physical examination is striking in view of the subsequent anatomic findings. However, this may be explained by the fact that the lesion is predominantly interstitial in location. A fairly constant finding is that of harsh breath sounds. The presence of crackling and moist rales, together with intensified or distant breath sounds, may be due to the focal bronchopneumonia present in some instances in association with the interstitial fibrosis. The disparity between the physical findings and the roentgenographic appearance is not surprising since similar

features have been noted in so-called atypical or virus pneumonia, a disease in which the anatomic lesion is also predominantly in the interstitial tissue, usually about the bronchi.

The term acute diffuse interstitial fibrosis of the lungs was introduced by Hamman and Rich to describe a comparatively rare group of cases characterized by an acute clinical course and terminating fatally. The predominating symptoms are those of progressive dyspnea, cyanosis and a harassing non-productive cough, with death in respiratory failure or in failure of the right side of the heart. The pathologic features are those of diffuse fibrosis of the alveolar walls, with little involvement of the alveolar lumens.—*E. J. McDonald, M.D.*

BARDEN, ROBERT P., and COOPER, DAVID A.

The roentgen appearance of the chest in diseases affecting the peripheral vascular system of the lungs. *Radiology*, July, 1948, 51, 44-57.

This very interesting article describes the roentgen appearance of the chest in diseases which involve the peripheral vascular system of the lungs with reference to those conditions which produce an increased vascular permeability. In the field of allergy and pulmonary pathology, investigators have demonstrated the relationship of hypersensitivity states to pathologic changes in peripheral vessels. Rabbits sensitized to horse serum were injected with small amounts of antigen. Lesions were produced throughout the animal which were identical with the pathological lesions in patients dying with acute rheumatic fever, periarteritis nodosa, and serum sickness. The essential changes were widespread areas of focal necrosis in small arterioles and capillaries accompanied by a perivascular inflammatory reaction which may go on to healing with characteristic scar tissue.

Since a variety of clinical conditions may produce similar pathologic changes in peripheral blood vessels through the body, it is reasonable to assume that the changes in the lungs may reflect the entire pathological picture of the disease. The following disease conditions are considered:

Trauma. A direct blow or an explosive blast may by actual rupture or change of tone of the capillary walls cause increased vascular permeability. With the former the roentgenogram may show a localized dense lobar con-

solidation, while with a blast injury, patchy shadows over both lung fields are seen, because the entire capillary bed of the lungs may be affected. A careful clinical history and the rapid disappearance of the lung changes tend to differentiate this lesion from an infectious one.

Epidemic Influenza. An actual anatomic change in the lung capillaries is absent, but there is an increased permeability, probably due to some toxin elaborated by the organism. Massive edema and hemorrhage gradually increasing in severity produce a peripheral haze on the chest roentgenogram which gradually moves toward the hila, and becomes confluent until the entire lung is obscured.

Disseminated Lupus Erythematosus. The changes in the chest roentgenograms may be similar to those of epidemic influenza. The changes are produced by necrotizing arteritis involving the arterioles of most organs of the body.

Acute Rheumatic Fever. This is primarily a collagenous degeneration and polyarteritis which involves many organs other than the heart. The term "rheumatic pneumonitis" to describe the roentgen changes in acute rheumatic fever is a useful one. A diffuse haze involves the middle and upper portions of the lung fields in a rather symmetrical manner. This appearance often occurs without evidence of heart failure, and is not associated with enlargement of the hilar shadows.

Exfoliative Dermatitis. This disease caused by many toxic agents may produce pathologic changes in other organs beside the skin. Roentgenograms of the chest during the acute phase may show a diffuse haze over both lung fields due to edema. The nature of the pulmonary shadows and the uniform diffuse symmetrical character suggest a focal perivascular origin.

Acute Glomerulonephritis. In this condition transient pleural effusions and pulmonary changes may be observed on the chest roentgenogram. It is probable that the same agent which causes the increased permeability of the subcutaneous peripheral vessels, accounting for the visible edema, may affect the pulmonary vessels as well. Again, as in acute rheumatic fever, without evidence of cardiac failure, passive congestion cannot be responsible for the chest findings.

Periarteritis Nodosa. This disease may co-exist with or be indistinguishable from any of

the previous conditions mentioned. The histopathologic lesion is a focal arteritis and may involve vessels in any organ. The small pulmonary vessels are thought to be involved in about 30 per cent of cases. Most of the patients will show pulmonary changes roentgenographically. In the acute stage of the disease, the roentgen shadows are massive and symmetrical, extending from the hilum to the middle lung zone. These changes may completely disappear in forty-eight hours if anti-allergic drugs are administered. Changes in the permeability of the vessel walls are considered the cause for the sudden onset and rapid clearing of the lung picture. In the chronic form of periarteritis nodosa the roentgen findings suggest bronchopneumonia, but the small patchy shadows migrate throughout the lung fields.

"Loeffler's Syndrome." This syndrome has been considered a manifestation of allergy and has been associated with migratory pulmonary shadows on the chest roentgenogram, and an eosinophilia in the blood. The roentgen appearance suggests a chronic symmetrical bronchopneumonia, but is not characteristic of pulmonary vascular disease.

The authors have presented a logical approach to the correlation of the roentgen appearance of the chest in hypersensitivity states with the basic pathologic changes which have affected the peripheral vascular system.—*George P. Keefer, M.D.*

POTTS, WILLIS J., and GIBSON, STANLEY.
Aortic pulmonary anastomosis in congenital pulmonary stenosis. *J.A.M.A.*, May 22, 1948, 137, 343-351.

In November, 1946, Potts, Smith and Gibson reported a new surgical procedure for the relief of congenital pulmonary stenosis. The operation consisted of a direct anastomosis between the aorta and the pulmonary artery. The use of the aorta was made possible by the invention of a clamp which permits blood to flow through this vessel while the anastomosis is being performed. The operation differs from the Blalock and Taussig method only in the fact that the aorta itself rather than one of its branches is used to direct additional blood to the lungs.

This is a report on the authors' experience with this operation in 45 patients. An additional 7 patients were explored but operation could not be accomplished.

The article reiterates the criterion for diagnosis of tetralogy of Fallot and the variations from the classical physical findings and symptoms. It is pointed out that the roentgenological examination is probably the most important single feature of the examination. A roentgenogram in the posteroanterior position almost always reveals a heart that is normal in size or only slightly enlarged. Gross cardiac enlargement militates strongly against the diagnosis of tetralogy of Fallot. The shape of the heart is subject to considerable variation. It is gratifying if the film shows a heart that is boot shaped, appearing to ride high on the diaphragm, lying more or less transversely in the chest. However, the heart contour may be normal. A slight concavity is usually present in the pulmonary area. Prominence in the pulmonary conus area indicates a large pulmonary artery and should immediately cast doubt on the diagnosis of tetralogy of Fallot. The appearance of the hilar regions must also be noted. If there is evidence of increased vascularity, it is an important sign that the lungs are receiving a sufficient amount of blood. Fluoroscopic examination is important in determining the amount of blood flow through the pulmonary arteries. With the eyes thoroughly accommodated search should be made for expansile pulsations in the hilar regions. Absence of pulsation is the rule in pulmonary stenosis. Fluoroscopic examination in the left anterior oblique is obligatory. In this position one is able to determine whether there is an abnormally clear area below the aortic arch; in other words, whether the pulmonary arteries are carrying less blood than normal. An abnormally clear pulmonary window is one of the most reliable signs of pulmonary stenosis. One should be very sure that the patient does not also have a right-sided aorta, as it is very important to the surgeon as to what side he attempts to make his anastomosis. Approximately 15 to 20 per cent of cases the aorta descends on the right. In most instances this is easily determined with a barium swallow.

In 4 of the patients coming to operation, the clinical diagnosis was tricuspid atresia. The physical signs are identical with those encountered in tetralogy of Fallot. There are two distinguishing characteristics, however. The roentgen silhouette in the anteroposterior view shows a gentle rounding of the left cardiac border due to hypertrophy of the left ventricle and an absence of the normal fullness in the region of the right ventricle. The second diag-

nostic feature is left axis deviation in the electrocardiogram.

The mortality of the operation on the 45 patients in whom the anastomosis was performed was 8.8 per cent. Most of these patients prior to operation were severely crippled and of the 41 who survived the surgery, 39 have been markedly improved. It has been only a year since the first child was operated upon when this report was made, so it is not possible to determine the ultimate prognosis in this group of cases.—*E. A. Addington; M.D.*

MACLEAN, K. S. The relation of idiopathic pleurisy and pleural effusion to tuberculosis. *Guy's Hosp. Rep.*, 1948, 97, 133-184.

This paper is based on the author's thesis approved for the degree of M.D. (Cambridge). It includes: a review of early observations and views on pleurisy; the change in the medical profession's attitude brought about by Koch's discovery; a tabulation of,—and discussion of the discrepancies in,—the more important follow-up studies of patients with pleural effusion; an extensive list of references; and a report of Maclean's study of the records of 183 patients with pleural effusion and 126 patients with dry pleurisy who had been admitted to the three main Royal Navy Hospitals in England during 1940 and 1941, and who had been followed for three years or more.

From the last come these conclusions:

(1) Many instances of dry pleurisy (as opposed to pleural effusion) are due to causes other than tuberculosis. The tuberculous morbidity in the three to four years after return to duty following pleural effusion was 15.9 per cent; following dry pleurisy, it was 1.9 per cent. Considering all factors, the tuberculous morbidity in a five year period following pleural effusion in the Royal Navy is approximately 25 per cent. However, the history of a pleuritic incident six months before the development of fluid was surprisingly frequent in the analysis of patients with pleural effusion. This sequence of events seems strong evidence of a tuberculous etiology and is presumably due to the different response of the pleura before and after tuberculin hypersensitivity has developed. Therefore, every patient with unexplained dry pleurisy should be carefully observed; if no further evidence of tuberculosis occurs in nine months, the likelihood of subsequent infection is slight.

(2) Pleural fluid complicates obvious pulmonary tuberculosis "much less frequently than might be expected." Miliary tuberculosis is infrequently accompanied by an effusion. From other authors' studies, Maclean concludes that many adults develop wet pleurisy some months after Mantoux conversion.

(3) Subsequent tuberculosis is more likely to occur when the effusion is large, *its duration is long*—for "several months" (the most important single prognostic factor, by far), pyrexia is sustained, and (less definitely) if the patient fall in the 20–30 year age group.

(4) The commonest site for tuberculosis to develop following pleural effusion is the upper part of the lung fields, usually on the same side as the effusion. About two-thirds of relapses occur within two years.

(5) Probably the commonest cause of pleural effusion in patients over forty is malignancy. This fluid is far more often bloodstained than is a tuberculous effusion. An effusion in a patient suffering from bronchial neoplasm, although of grave prognostic significance, does not necessarily imply that the case is beyond surgical aid.—*Henry G. Moehring, M.D.*

GOODRICH, WILLIAM A. Pulmonary edema. *Radiology*, July, 1948, 51, 58–65.

The physiological factors which produce pulmonary edema are reviewed. These are (1) increased intracapillary hydrostatic pressure; (2) decreased osmotic pressure of the blood; (3) increased capillary permeability.

The variation in these basic physiological factors caused by cardiac failure, nephritis, excessive administration of parenteral fluid, and the mechanism of production and location of pulmonary edema as observed on the chest film in each condition are described in some detail.

To differentiate the shadows produced by pulmonary edema and in chest films from other conditions, the author lists the following observations: (1) the diffuseness of the shadows; (2) relative clearness of the extreme apical and basal lung fields; (3) a tendency for the shadows to vary in size and to show a shift in location on serial films; (4) enlargement of the vascular shadows; (5) enlargement of the heart.

In cardiac failure, where pulmonary edema results from increased hydrostatic pressure and increased capillary permeability, pleural effusion is more commonly seen with chronic

failure. In acute failure, the edema tends to occur in the central portion of the lungs, the apices and bases are clear and pleural effusion is seldom seen.

Nephritis may cause pulmonary edema by variations in one or all of the three basic physiologic factors, i.e.: a low serum protein, plus low osmotic pressure in pure nephrotic nephritis; increased capillary permeability and increased hydrostatic pressure in acute glomerulonephritis.

With the excessive administration of parenteral fluids, hydrostatic pressure increases, serum proteins are decreased, and osmotic pressure of the blood is lowered. Cardiac enlargement and pleural effusion may accompany the pulmonary edema.—*George P. Keefer, M.D.*

ABDOMEN

GREENWOOD, FRANK, and SAMUEL, ERIC. The pathological gallbladder. *Brit. J. Radiol.*, Sept., 1948, 21, 438–445.

The authors, from Johannesburg, South Africa, have analyzed 500 consecutive cholecystographic examinations. When the gallbladder was not visualized after one dose of the opaque medium, or was poorly visualized (i.e., not seen fluoroscopically), two further doses were administered at twenty-four and forty-eight hour intervals. Films were made in prone and erect positions with and without compression and if necessary tomography was resorted to. Three hundred and sixty-two were finally regarded as normal, but of these 36 had to have the extra two doses for demonstration of this fact. In other words, 1 out of 10 normal gallbladders requires the three dose technique.

Of the abnormal 138 cases, 32 per cent showed no function and no stones were visible. Many of these did not submit to surgery, so the number with stones could not be determined. Of the remaining 94, one-third had opaque stones which could be seen without cholecystography, and two-thirds showed nonopaque stones.

Eighteen per cent of these 94 showed stones which could be seen only in the erect position, and it is the authors' opinion that routine fluoroscopy of the gallbladder in the erect position, using serial roentgenography and compression, is essential in every examination of the gallbladder. Tomography is valuable if the gallbladder cannot be separated from overlying intestinal gas.—*E. F. Lang, M.D.*

HUGHES, C. R., HANNAN, J. R., and MULVEY, B. E. Cholangiography in stone stricture and operative injury of biliary ducts. *J.A.M.A.*, June 19, 1948, 137, 687-690.

The authors review their experience in 90 consecutive patients who have had exploration of the common duct for stone, stricture or stenosis of the biliary duct.

The indications for cholangiography include all patients showing jaundice or a history of jaundice; if multiple small stones are found in the gallbladder at operation; if the ducts are dilated or obviously diseased; if a stone in the duct is suspected on palpation; if a small fibrotic gallbladder is discovered; if bile aspirated from the duct is muddy; if the liver is cirrhotic.

The authors use 35 per cent iodopyracet solution. The dye is observed under fluoroscopic visualization as injected. Spot films are taken at the time of injection and at fifteen and thirty minutes following the injection. Post-operative cholangiography was 93.3 per cent accurate in demonstrating common duct stones not found at previous surgical exploration. The examination is done at the time of operation and repeated later before removal of the T tube. Cholangiograms following operation for stricture are of value to show the rate of entrance of bile through the anastomosis into the duodenum.—*V. L. Peterson, M.D.*

GOIN, LOWELL S. Fibrocystic disease of the pancreas. *Radiology*, July, 1948, 51, 36-43.

The author reviews in some detail the clinical, pathologic and roentgen findings observed in fibrocystic disease of the pancreas. While this disease was considered rather rare, autopsies indicate that it accounts for about 4 per cent of infant deaths. The disease is probably of congenital origin, since it occurs frequently in the newborn and in more than one child in a family. It is characterized by repeated respiratory infections; signs and symptoms of celiac-like disease. The cause of the disease is unknown, but an obstruction of the small pancreatic ducts and subsequent dilatation of the acini is very likely a basic factor. Most observers believe that a vitamin A deficiency caused by absent or inadequate pancreatic enzymes produces the lowered resistance of the lung to infection, and the resulting pulmonary picture.

Histopathologic examination of the pancreas shows atrophy of the acinar parenchyma;

interacinar and interlobular connective tissue is increased. The lungs are the site of suppurative bronchitis and bronchiectasis. Bronchopneumonic patches are scattered through the pulmonary tissue.

These lung changes account for the bilateral hilar prominence, linear densities, bronchopneumonic patches, and occasional localized areas of emphysema seen on the roentgenogram of the chest. These findings should make us suspect the presence of pancreatic fibrocystic disease, especially when associated with gastrointestinal symptoms of celiac-like disease.

Children with this disease fall into three groups:

1. Those who die in the first week or two with meconium ileus, intestinal stenosis or atresia.
2. Those who, usually in their first year, display gastrointestinal and respiratory tract findings, the presenting symptoms usually being those of pulmonary infection. This group has repeated attacks of cyanosis and die of respiratory infection.
3. Those who present signs and symptoms of celiac-like disease—i.e., failure of weight gain, foul and foamy stools, intolerance to fats and carbohydrates, associated with bronchitis and bronchiectasis.

If the disease is recognized early, adequate treatment can be instituted and some babies may be saved. Therapy is directed to the control of the pulmonary tract infection by chemotherapy and antibiotics. Establishment of adequate diet is obtained by supplemental feeding of the pancreatic enzymes, casein hydrolyzates, etc.—*George P. Keefer, M.D.*

SELMAN, JOSEPH, and BENDER, JOHN R. Mesenteric lipoma in a child. *Radiology*, July, 1948, 51, 66-70.

The literature dealing with lipomas and other fatty tumors is reviewed. The paucity of reported cases of intra-abdominal lipoma is noted.

The authors report a single case of mesenteric lipoma in which a preoperative roentgen diagnosis was made. The report is illustrated with reproductions of two roentgenograms. The reproductions are of sufficient quality to demonstrate the radiolucency of the tumor.—*Richard E. Kinzer, M.D.*

LIKELY, STANLEY DAVID, LISA, JAMES R., STITCH, MELVIN H., and STEIN, H. D. Primary malignant disease of the small bowel. *Arch. Int. Med.*, August, 1948, 82, 206-216.

Seventeen cases of malignant growth of the small bowel are reported, and the recent literature is reviewed. They are of uncommon occurrence. Certain clinical features suggest the possibility of their presence. Intermittent obstruction is a common manifestation. In some cases the presenting symptom is mild unexplained nausea. In the presence of anemia of gastrointestinal origin for which no adequate explanation is found on examination of the stomach and large bowel, the small bowel should be thoroughly investigated. The prognosis is usually considered poor in cases of carcinoma and lymphosarcoma and good in cases of argentaffinoma. The more recent literature suggests that the prognosis may depend largely on early diagnosis rather than on the type of tumor, particularly in reference to carcinoma and lymphosarcoma. Roentgenologic studies are most valuable. The therapy is radical resection. Awareness of the possibility of the existence of the condition remains the prime necessity for early diagnosis.—*E. J. McDonald, M.D.*

WELLS, JOSEPHINE. Mucosal pattern of the terminal ileum in children. *Radiology*, Sept., 1948, 51, 305-309.

While the normal mucosal pattern of the barium-filled terminal ileum in the adult on pressure appears as slender regular lines produced by the mucosal folds, that in children is found to present a different pattern. Here there are noted small rounded filling defects giving a cobble-stone appearance. The writer demonstrated this in 14 cases of children having no history of gastrointestinal symptoms. Another child who died of a non-relevant condition was autopsied and the lymph node collections were numerous in the terminal ileum. A barium sulfate suspension was smeared on the surface and the typical cobble-stone appearance was demonstrated on roentgen examination. The writer concludes that this appearance is normal in children and is due to the lymphoid tissue which is more marked than in adults. Occasionally in young adults having an inflammatory lesion in the ileum with local lymphadenitis the cobble-stone appearance may also be noted.—*J. Paul Bennett, M.D.*

PENDERGRASS, ROBERT C. Extrinsic deformities of the colon. *Radiology*, Sept., 1948, 51, 320-325.

The difficulty of differentiation of extrinsic and intrinsic defects of the colon is pointed out. No hard and fast rules can be drawn. Even after correlation of the history, physical findings, roentgenologic data and knowledge of the anatomy and pathology, one cannot honestly state whether a defect is intrinsic or extrinsic.

Extrinsic deformities of the colon may be roughly grouped as follows: (1) deformities from enlarged viscera, including tumors of these viscera; (2) deformities from inflammatory processes, adhesions, and endometriosis; (3) deformities from retroperitoneal tumors, mesenteric tumors, and omental tumors; (4) deformities from tumors of the colonic wall not invading the mucosa; (5) deformity from intra-abdominal and inguinal hernia.

The author has found it very helpful, in certain instances, to make a vaginal examination under fluoroscopic observation while the colon is filled with barium. This procedure helps to separate masses in the right pelvis from the distended cecum. On occasion, a mass thought to be an ovarian cyst has been demonstrated to be a distended pelvic cecum.—*Chauncey N. Borman, M.D.*

BELL, JOSEPH C., and DOUGLAS, JAMES B. Roentgen-ray diagnosis of malignant and potentially malignant lesions of the colon and rectum. *Radiology*, Sept., 1948, 51, 297-304.

Because of public enlightenment patients are now seeing their physicians earlier in cases of cancer. Malignancies of the colon are consequently encountered by the physician at an earlier stage, at which diagnosis is more difficult. Seventeen per cent of all deaths caused by cancer are due to cancer of the colon or rectum. The radiologist should obtain detailed history concerning bowel habits, abdominal discomfort or pain interfering with passage of material, rectal bleeding, indigestion and evidence of progressive anemia, if such history is not supplied. Sigmoidoscopy is important in the study of the rectum and sigmoid; some lesions not demonstrable by roentgen ray may be so demonstrated. The use of sigmoidoscopy in conjunction with the roentgen study should therefore be advised by the roentgenologist. Cleansing of the bowel thoroughly both before sigmoidoscopy and the barium study is of great

importance. The authors use castor oil for this purpose.

The writers make the examinations of the colon in the right and left oblique projections, the angles being determined by the fluoroscopic findings. A true lateral projection of the filled rectum and rectosigmoid region is also obtained after which a film of the entire colon is made in the posteroanterior projection after filling and also after evacuation. The writers have a special three-contact quick change-over switch in parallel with the change-over switching apparatus in the spot film tunnel permitting an exact duplication on the film of any roentgenoscopic image by placing the cassette over the area of interest. Serial exposures aid in differentiating stricture due to diverticulitis from a cancer. If there is any question concerning the nature and significance of a filling defect it is essential that re-examination be made at the earliest possible time.

Double contrast examinations are of value, especially in demonstrating polyps. The routine barium enema will seldom demonstrate these. The writers state that the ordinary barium enema study and the double contrast require such different techniques as to necessitate separate examinations rather than a combination of the two. They use twice as heavy a barium sulfate concentration for the contrast study as for the ordinary barium enema. Stereoscopic films are made in the prone and right posteroanterior oblique positions before expulsion of the air. As polyps are acknowledged to be potentially malignant, the double contrast study is of importance. For the demonstration of polyps in the rectum and sigmoid, sigmoidoscopy is the most accurate method. There should be close cooperation between the sigmoidoscopist and the radiologist. Even when proctoscopy reveals a low polyp the barium study should be made as additional polyps may be found at a higher level.

An examination of a large number of cases of cancer of the colon and rectum revealed that slightly over 50 per cent of the lesions proved to be operable and free of demonstrable cancer after five years. If the diagnosis is made before there is lymph node involvement, these results can be improved by probably 10 per cent.—*J. Paul Bennett, M.D.*

SKELETAL SYSTEM

PETERMAN, M. G., FREY, W. B., and KASTER, J. D. Value of routine roentgenograms of the

wrist in a pediatric service. *Am. J. Dis. Child.*, May, 1948, 75, 671-687.

This paper is a report of the investigation of 684 infants and children for evidence of a pathologic process by means of routine roentgenograms of the wrists. For means of determining a delay in the centers of ossification the revised Leonard "ossification index" was used exclusively. A number of pathologic findings were visualized which were consistent with the following conditions: rickets, hypothyroidism (delayed ossification), cerebral birth injury (delayed ossification), mental retardation (delayed ossification), fibrocystic disease of the pancreas (delayed ossification), pituitary dwarfism (delayed ossification), cerebral dysgenesis with hypothyroidism (delayed ossification), delayed ossification (cause undetermined), scurvy, syphilis, lead intoxication, mongoloidism, osteochondromatosis, chondrodystrophy, pubertas precox, and osseous changes not attributable to any definite clinical entity.

Two series were done independently, one in a private pediatric service, and the other in a charity hospital pediatric service. Of 333 hospital cases 34, or 10.21 per cent, and of 351 private patients studied 35, or 9.97 per cent, of the roentgenograms of the wrists revealed evidence of a pathologic process.—*R. S. Bromer, M.D.*

STEINBERG, CHARLES LEROY. Brucellosis as a cause of sacro-iliac arthritis. *J.A.M.A.*, Sept. 4, 1948, 138, 15-19.

The author gives a short introductory general discussion of brucellosis followed by an analysis of other writers on the subject, particularly as it pertains to joint pains. A serologically but not bacteriologically proved case report is given. In addition to the usual other symptoms the patient complained of pain in the hip. This was shown to be due to well defined areas of destructive arthritis in the sacroiliac synchondroses.

The question is raised as to whether rheumatoid arthritis is due to brucellosis. After a study of 20 cases of rheumatoid spondylitis, the writer's answer is no.—*Allan Tuggle, M.D.*

MARÓTTOLI, OSCAR R. Concepto general de pseudoartrosis. Consideraciones estadísticas. (A general concept of pseudarthrosis; statistical considerations.) *An. de cir.*, March, 1948, 13, 23-32.

The author discusses the North American

on non-union of fractures, covering general and specific causes. He quotes classifications of non-union, and recommends that advocated by Codivilla, in 1909, seems most workable, comprising only union and true non-union. True non-union is divided into cases with and without loss of bony substance. Those without loss of bone are further divided into recent cases with and without difficulty in immobilization, and older cases in which osteoplastic capacity is impaired or lost.

There is considerable discussion of changes in osteoplastic activity due to atrophy and eburnation of fractured ends, and due to soft tissue interposition.

A large series of statistics from Europe and South America is quoted; all, as in this country, show that non-union is most common in the navicular and the femoral neck.

The author quotes a series of over 7,000 personally treated patients with fractures of all bones, with only 8 cases of true non-union, a phenomenally low percentage of 0.001.

No mention is made of further surgical therapy in true non-union.—*William S. Wallace, M.D.*

CASSIDY, WILLIAM J., ALLMAN, FRANCIS C., and KEEFE, GERALD J. Osteopetrosis. *Arch. Int. Med.*, August, 1948, 82, 140-158.

Roentgenologically considered, osteopetrosis is a skeletal dystrophy in which increase in the density of the roentgenographic shadow cast by bone is the most characteristic feature. The usual architectural features of normal bone, such as fine trabeculations of the substantia spongiosa, well proportioned cortices and marrow cavities, careful modeling or tubulation and sharply contrasting densities, are missing. The building of osteopetrotic bone appears to have been sublet to an amateurish contractor, who had an abundance of mineral salts available and used them with a lavish, if untrained, hand. While the long bones, ribs and pelvis are the structures most commonly involved, the head, the spine and the bones of the hands and feet are frequently seen to manifest the changes of this disease.

While decidedly dense, osteopetrotic bone is not always uniformly so. Striking variations often occur in the shafts of the long bones, the carpal and tarsal bones and in the flaring portions of the iliac bones. At times translucent bands of decreased density of varying width

are seen near the epiphyseal plate and often extending well up the diaphysis. These are transverse strata of defective loose substantia spongiosa. They represent a period of growth in which excessive destruction of cartilaginous lattice has occurred and are somewhat of a paradox in osteopetrosis. Certainly some interruption or temporary cessation of the usual course of events in the laying down of osteopetrotic bone has occurred.

The frequent association of osteopetrosis with osteomyelitis and delayed dentition are probably attributable to an impaired vascular supply, and consequently the nutritive requirements for normal development and maintenance of a healthy state are inadequate. Fractures, likewise, are a common observation in the patient with osteopetrosis. These usually heal with the production of adequate, and at times, abundant, callus. However, delayed union is not unusual. Evidence of healed or healing fractures has been discovered with the patient having been unaware of their occurrence.

Ordinarily, the base of the skull is first and most decidedly affected by this disease. The bones of the calvarium, however, may also be involved and become so uniformly dense that no distinction can be made in the tables and the diploic portion. Obliteration and effacement of the mastoid cells and air spaces of the paranasal sinuses are fairly common. Narrowing of the various foramina of the skull, with compression of the corresponding emerging nerves, is not rare.

In the infant the outlook for life is generally poor, with death resulting from extreme inanition and intercurrent infection. Those who do survive usually have the stigmas of blindness, deafness, hydrocephalus, anemia and multiple fractures. In the adult, except for anemia and multiple fractures, the prognosis is generally favorable. Osteomyelitis is a serious complication. The treatment is ineffective. Several attempts have been made to mobilize calcium without success.

The authors' review of the entire subject is complete, well presented and substantiated by a voluminous bibliography.—*Eugene J. McDonald, M.D.*

RATHBURN, J. C. Hypophosphatasia. *Am. J. Dis. Child.*, June, 1948, 75, 822-831.

In this paper an unusual and previously unreported type of faulty bone development is

presented. A low to absent alkaline phosphatase appeared to be the primary defect responsible for the clinical picture. The patient was a boy, three weeks of age, born at full term following a normal seven hour labor. There was no familial history of bone diseases in two generations prior to this child. The roentgen examination showed marked decalcification throughout the bones of the body, membranous and cartilaginous. Decalcification was very striking in the skull, there being only a few patches of ossification present in the parietal and frontal regions. The base of the skull was moderately well calcified. The posterior arches of the lumbar vertebrae were indistinguishable from the soft tissue shadows, and the ribs of the thorax showed deformities and flaring of their ends. Some of most prominent areas showing lack of normal calcium density were seen at the metaphyseal ends of the long bones. Trabecular projections of non-osseous density, extending up into the diaphysis, were seen. The epiphyses appeared to be unaffected, except for a slight degree of osteoporosis and it would appear that the bony maturation, so far as the secondary epiphyseal centers at the knee were concerned, was within normal limits.

The alkaline phosphatase ranged during the patient's stay in the hospital from 0.4 to 0.0 and 0.15 Lowry-Bessey units, the normal range for children being 5.15 U. At postmortem, the long bones showed normal hyaline cartilage at the growing ends below the articular cartilage. There was a wide, irregular zone of proliferative cartilage with disorganized maturation of cartilage cells and no evidence of calcification of the intercellular matrix. The normal regular invasion of cartilage by capillaries was completely disrupted and as a result, long, irregular, cartilaginous processes projected into developing osteoid tissue. The osteoid tissue was deposited abundantly on the uncalcified cartilaginous intercellular substance and on the outside of the shaft but was almost completely uncalcified for some distance along the shaft. This accounted for fractures seen in a radius and an ulna. The picture resembled that of severe rickets. The vault of the skull showed a most unusual picture, the bony framework having been laid down perfectly in the form of osteoid tissue.

The membranous condition of the vault of the skull with the slightly elevated serum calcium and phosphorus suggested the possibility of osteogenesis imperfecta as the diag-

nosis. However, in osteogenesis imperfecta, micromelia is secondary to fracture, the nose is of normal contour, the serum phosphatase is normal or increased, and the long bones are slender with thin cortices. Microscopically osteogenesis imperfecta usually shows a short zone of proliferative cartilage, whereas in the case reported, the proliferative cartilage was increased and was highly irregular. Rathbun also felt that achondroplasia and renal hyperparathyroidism could be excluded.

Treatment failed to change the course of the disease.—*R. S. Bromer, M.D.*

LAPIDUS, PAUL W., SLOBODY, LAWRENCE B., GERMANSKY, GEOFRED, and WILLNER, MILTON M. Eosinophilic granuloma of bone; report of three cases. *Am. J. Dis. Child.*, June, 1948, 75, 900-909.

Three cases of eosinophilic granuloma of bone are reported which are added to 62 previously reported cases. The first patient had a lesion in the upper humeral shaft, the second in the sternum and the third in the roof of the acetabulum. The authors regard eosinophilic granuloma as a benign, probably inflammatory lesion of unknown origin which may be multiple or solitary. They regard the changes in the roentgenogram, although presenting certain diagnostic features, as not characteristic enough for any positive diagnosis. Usually round, ovoid or irregular, punched-out areas of varying size occur. The osteolytic lesions apparently originate in the medullary portion of the bone and have a fairly well outlined, occasionally sclerotic, margin. Since the lesion rapidly increases in size, it may cause cortical perforation or sometimes expansion of the cortex. Periosteal proliferation and cortical thickening also may simultaneously be produced with expansion of the lesion. Pathologic fractures of the weakened bone are frequently produced, followed by periosteal callus formation and rapid healing.—*R. S. Bromer, M.D.*

GENERAL

ARDRAN, G. M. *Armiller armillatus*; a note on three cases of calcification of the cysts in man. *Brit. J. Radiol.*, July, 1948, 21, 342-345.

Armiller armillatus, an arthropod and one of the tongue worms or linguatulidae, lives as an adult in the bronchial tree of snakes, and its eggs can be transmitted to the gastrointestinal tracts of men who handle infested

snakes. The eggs develop into larvae or nymphs which eventually encyst in the peritoneum or in any of the organs of the celomic cavity. Only a small percentage of the nymphs calcify and by that time they are dead and not productive of symptoms. The calcifications are circular or C-shaped, with the band of calcification about 3-5 mm. in width, and the overall diameter of the cyst 3-4 cm.

Calcifications have been found in the lung, in the peritoneal cavity, on the peritoneum and in the liver. The calcifications are entirely typical and cannot be mistaken for other conditions if they are seen en face.

Infestation is known as porocephaly.—*E. F. Lang, M.D.*

BLANCHARD, A. J., and BOONE, F. H. Reticulo-endothelial granulomatosis; report of two cases of Hand-Schüller-Christian disease. *Am. J. Dis. Child.*, July, 1948, 76, 1-13.

The authors present 2 cases of Hand-Schüller-Christian disease the features of which tend to support the hypothesis that the condition is a systemic reticulo-endothelial granuloma of unknown origin. They produce evidence to suggest that the presence of cholesterol in the lesion is a secondary consideration resulting from the ingestion of the lipid from the tissue fluids by the macrophages of the preformed granulomas.

They state that this theory fits the well recognized fact that the value for serum cholesterol is normal in most cases. With the onset of necrosis in the lesions, this ingested cholesterol is liberated from the cells and is observed lying free in the lesions in crystalline form. From these sites it may be absorbed into the blood stream and give rise to a transient hypercholesteremia.

Hand-Schüller-Christian disease has been grouped with Niemann-Pick disease and Gaucher's disease as a primary congenital lipodystrophy. In support of this theory, the hypercholesteremia of some of the cases and the xanthomatous nature of the lesions were cited. However, with the study of increasing numbers of cases, it was observed that the great majority did not show a significant increase in blood cholesterol and that in the various lesions encountered in a given case, foam cells were often a minor feature. The 2 cases reported tend to support this hypothesis. In the original descriptions of the disease, emphasis was laid particularly on the clinical and roentgenologic

observations, rather than on the more fundamental anatomic bases. Gradually, with study of increasing numbers of cases it has been recognized that the clinical features in a given case depended solely on the localization of the xanthomatous deposits. Thus, the clinical conception of the condition became wider and wider. It was emphasized consistently that the histologic criterion necessary for anatomic diagnosis was the presence of foam cells in cholesterol-containing granulomas.

With this criterion in mind, a number of cases showing reticuloendothelial granulomas were described. These were considered by the authors as entities distinct from Hand-Schüller-Christian disease and excluded that diagnosis chiefly because of the absence of foam cells from the lesions. Among these conditions may be mentioned: (1) infectious reticuloendotheliosis, (2) Letterer-Siwe disease and (3) solitary or eosinophilic granuloma of bone. Wallgren considered that the infectious reticuloendotheliosis and Letterer-Siwe disease were essentially the same condition and classified them as non-lipid reticuloendotheliosis. The authors regard Wallgren's cases as a definite link between this group of cases and Hand-Schüller-Christian disease.

With regard to eosinophilic granuloma of bone, the authors quote Farber and Gross who suggested that the condition should be considered as exceptional examples of Hand-Schüller-Christian disease, with a single bony lesion and minimal visceral damage.

The authors' first case showed dissemination of reticuloendothelial granulomas which, although showing an occasional fatty droplet, failed to exhibit the characteristics of foam cells and cholesterol crystals. Tumor-like proliferation of the macrophages was particularly striking in the biopsy specimen from the skull, which showed a considerable number of mitotic figures.

In the second case the most pronounced changes were present in the lungs, skin and ribs and skull. The peculiar cutaneous infiltration is described in cases of Letterer-Siwe's disease. In the original biopsy specimen from the rib the histopathologic features were those of a non-lipid granuloma. At the autopsy several months later, sections from the same area showed extensive necrosis with acicular spaces representing cholesterol crystals and there was massive infiltration of foam cells. In the earlier stages the case presented features

described in Letterer-Siwe disease, but with full maturation of the lesions, the complete picture of Hand-Schüller-Christian disease was evident. This case seems to support Wallgren's contention that the two conditions are essentially the same and represent merely the early and the late stages of one process.—*R. S. Bromer, M.D.*

LINDSAY, STUART, REILLY, WILLIAM ANTHONY, GOTHAM, THELMA J., and SKAHEN, RICHARD. Gargoylism. II. Study of pathologic lesions and clinical review of twelve cases. *Am. J. Dis. Child.*, Sept., 1948, 76, 239-306.

This paper follows a previous publication by Reilly and Lindsay which gave in detail the clinical findings in 18 cases of gargoylism. In this paper the authors present a complete study of 12 cases, 8 of which came to autopsy and 4 in which surgical pathological findings were obtained. They discuss carbohydrate storage in the disease and its physiologic aspects, and also the relation to carbohydrate and other macromolecular storage diseases.

The case histories of the 12 cases are given in detail. Then follow sections on the review of pathologic lesions of the condition recorded in the literature, the cellular lesions, histochemical studies, hereditary aspects, leukocytes, and carbohydrate metabolism in gargoylism.

The author's summary and conclusions are:

1. Gargoylism is a disease of early childhood, characterized by striking gross and microscopic alterations in almost all tissues of the body.

2. The basic lesion is the intracellular and extracellular deposition and storage of a substance giving the histochemical reactions for glycogen.

3. Certain histochemical data presented suggest that the glycogen may be combined with protein.

4. Laboratory studies indicate that glycogen storage process in gargoylism is not associated with demonstrable alteration in carbohydrate metabolism, as in true glycogenosis (von Gierke's disease).

5. Widespread involvement of most tissues, including the nervous, cardiovascular, reticulo-endothelial, endocrine, skeletal and other systems, explains the protean clinical manifestations of the disease.

6. The lesions of gargoylism are similar to or identical with some of those of the other macromolecular storage diseases of both endogenous and exogenous origin.

7. Further, more precise, histochemical, chemical and enzymatic studies on the material stored in the tissues are indicated. Combination of glycogen with a protein stored in the cytoplasm of the cells may explain the inconsistent histochemical staining reactions recorded up to date.—*R. S. Bromer, M.D.*

ROENTGEN AND RADIUM THERAPY

GOLDMAN, R., EGEBERG, R. O., WARE, E. R., EVANS, E. R., and FISHKIN, B. G. Clinical experience with nitrogen mustard therapy. *Arch. Int. Med.*, August, 1948, 82, 125-139.

Forty male patients who had Hodgkin's disease, lymphosarcoma, leukemia and related diseases were treated with bis-beta-chloroethyl-amine hydrochloride (nitrogen mustard). The therapeutic application of the drug results in a prompt response which is more rapid than that which occurs after roentgen therapy, but the remission produced is of much shorter duration.

Nitrogen mustard appears to offer promise of almost certain remission in Hodgkin's disease and polycythemia vera. Lymphosarcoma, reticulum cell sarcoma, chronic leukemia and mycosis fungoides respond in slightly more than half of the cases, but such a result cannot be predicted in advance. The response of the other diseases appears to be less consistent, and the group of patients described in this report is too small to permit conclusions of a general nature. The earlier the clinical state of the disease, the more likely is the remission to be clinically significant and the more possible the restoration of the patient to social and economic usefulness. For diseases in which nitrogen mustard has proved occasionally useful, one course may be tried to determine the patient's response. This should be done for the remission itself and to defer the development of resistance to roentgen rays. Since the first adequate course of nitrogen mustard, judged by the hematopoietic response, appears to be the most effective, failure to respond to the first course obviates the necessity of repeating treatment. Recently, several research groups have begun to study the effects of nitrogen mustard when combined with roentgen therapy. It is hoped that this will prolong the duration of the remissions. The rapid response to the drug complements the slower but more prolonged effects of roentgen irradiation, and this in itself is of value.—*Eugene J. McDonald, M.D.*

SNAPPER, I. Treatment of multiple myeloma with stilbamidine. *J.A.M.A.*, June 5, 1948, 137, 513-516.

Thirty-five patients with multiple myeloma have been treated by intravenous or intramuscular injections of stilbamidine. The dose was 50 mg. the first day, 100 mg. the second day, and 150 mg. daily thereafter for fifteen to twenty doses. This is usually sufficient to alleviate pain. Daily treatments can be given only when the patient has normal renal function and no Bence-Jones proteinuria. In the presence of signs of renal damage the dose is given every other day. Weekly determination of blood urea nitrogen is required. The diet should be poor in animal protein.

Roentgen therapy may be helpful after the termination of the stilbamidine injections. Eighty per cent of the cases were relieved temporarily of pain. The disease is at best halted temporarily and relapses are frequent. Bence-Jones proteinuria and increase of globulin in the serum are not influenced. Stilbamidine appears to have a specific affinity for the abnormal nucleoproteins of the myeloma cells.—*Robert K. Arbuckle, M.D.*

KELLY, JAMES F., DOWELL, D. ARNOLD, and DOWNING, JOHN E. Roentgen rays in prevention and treatment of infections. *Radiology*, Sept., 1948, 51, 341-349.

The authors review the theory and clinical effects of roentgen treatment of infections and report 2 cases.

A seven year old girl developed tetanus five weeks after a foot injury. Roentgen therapy was started on the third day as there had been no response to antitetanus serum, penicillin, and streptomycin. The patient was free of evidence of toxemia four days after irradiation was started. Details of treatment are not given. The authors recommend roentgen therapy for tetanus in conjunction with other measures.

A case of gas gangrene involving the arm was given roentgen therapy starting the fourth day. Continued use of penicillin and anti-gas gangrene serum and repeated surgical removal of damaged tissue failed to prevent or control the gas infection. Not until roentgen therapy had time to take effect was improvement noted. Much infected tissue was never removed, but fully recovered under roentgen therapy.

The authors insist that tissues which may seem hopelessly diseased during the acute toxic phase often recover. They are not convinced

that penicillin is of any value and consider serum unnecessary if roentgen radiation is used.—*Arthur A. Brewer, M.D.*

RIEBELING, MANUEL. Roentgen treatment of external infections due to bacillus anthracis. *Radiology*, Sept., 1948, 51, 333-340.

Thirty-six patients with infections produced by *Bacillus anthracis* (demonstrated in smears in all cases) were treated with fractionated small doses of radiation of medium penetration. The factors as reported were: 140 kv., with filtration of "2.0 mm. aluminum to 0.25 mm. copper and aluminum," target-skin distance, 30 cm. Most cases were treated every 24 to 48 hours, the dose per field varying from 18 to 85 r. Treatment was "highly individualized."

Detailed case histories of 15 cases are reported. In all cases there was a prompt response to irradiation. *B. anthracis* disappeared from the exudate from the primary lesion and general and local manifestations subsided. No complications incident to treatment were observed.

Roentgen therapy appears to be of little significance for the mild localized infections, in many of which spontaneous recovery takes place. In cases with severe local or regional manifestations, such as those reported, the author believes the situation is quite different, and reports rapid and sometimes dramatic improvement in both the local and general condition.—*Chauncey N. Borman, M.D.*

BODEN, GEOFFREY. Radiation myelitis of the cervical spinal cord. *Brit. J. Radiol.*, Sept., 1948, 21, 464-469.

The roentgen treatment of 161 patients with various lesions in the neck necessitated inclusion of the cervical portion of the spinal cord in the field, and of these patients 10 developed transient or progressive cervical myelitis. The patients fell into two groups: 145 were treated with large fields, resulting in homogeneous dosage to the whole cervical area; the other group of 16 were treated by small field, beam-directed therapy. The first group were lymphomas, aplastic carcinomas of the nose, mouth, throat or cervical lymph nodes, or inoperable thyroid carcinomas. Small fields were used for carcinoma of the posterior pharynx in the region of the arytenoids, or in the posterior pharyngeal wall.

Four patients who developed transient myelitis showed subjective evidences only. When

physical signs developed, the lesion was progressive and the signs were those of partial transection of the cord. In these cases, disease of the cervical vertebrae, intra- and extramedullary cord lesions, and cord lesions were all carefully excluded but autopsy control was obtained in only two. Of the patients treated with large fields, 6 developed myelitis, 3 with permanent changes; in the other group of 16 treated with directed beams there were 4, three of which had permanent cord involvement. In each case where progressive lesions developed, it was found that a larger dose than intended had been given. One case had had a previous unknown amount of irradiation; in a second, the side of an equilateral triangle had been taken as the height; in another, there was spread of the beams at the margins of adjacent fields; and, in another, the treatment had been administered at a greater focus-skin distance than had been calculated.

Calculation of the dose to the center of the cord was carried out subsequently and the estimated upper limit of safe treatment to the cord is somewhat below 3,500 roentgens in seventeen days when large fields are being used. With small fields, the small number of patients prevents firm conclusions, but 5,000 to 5,500 roentgens in seventeen days, or 2,000 roentgens in one day will cause damage in a proportion of cases.—*E. F. Lang, M.D.*

SCHENCK, S. G. Radiation therapy for Wilms' tumor of the kidney. *J. Pediat.*, Dec., 1948, 33, 734-738.

The author outlines the accepted method of treatment of Wilms' tumors as follows:

1. Operation alone. This method is worthless in the presence of metastases or when the tumor is too large.

2. Operation and postoperative irradiation. This method has been the treatment of choice.

3. Preoperative roentgen irradiation. This method may make an inoperable tumor operable and minimize dissemination.

4. Preoperative and postoperative irradiation. This is the present accepted method by a majority of workers in this field. This method is at least the method of choice in the presence of metastases where it is used for palliation alone.

The usual roentgen technique, where a cure is possible, employs three portal, anterior, posterior, and lateral. The total dosage should be from 3,600 to 6,000 roentgens, treating one por-

tal daily. The total daily dose should not exceed 200 r. In cases of massive tumor six smaller portals may be used. Operation should be delayed for four to six weeks after completion of roentgen therapy. In the presence of metastases 800-1,200 r is given through three portals.

The author treated 17 patients from 1930-1947 with Wilms' tumor. All the cases died. Average survival rate was 6½ months. The statistics referable to the various forms of therapy were not conclusive as to the treatment of choice to be employed.—*Rolfe M. Harvey, M.D.*

ARNESON, A. N., STANBRO, WILLIAM W., and NOLAN, JAMES F. The use of multiple sources of radium within the uterus in the treatment of endometrial cancer. *Am. J. Obst. & Gynec.*, Jan., 1948, 55, 64-78.

This report is a study of a group of patients with carcinoma of the fundus of the uterus. The authors compare the results of treatment with gamma irradiation, using multiple weak radium capsules packed individually into the uterine cavity with the results obtained by the use of strong capsules placed in tandem in the uterine fundus.

In their group of 93 patients 45 were considered inoperable due to advanced cancer or some other lesion. Those patients who were treated by irradiation alone show a five year survival rate of 27 per cent, while those given preoperative roentgen therapy and intrauterine radium followed by hysterectomy show a 68 per cent survival for five years. Surgery alone was used in 18 patients of whom 84 per cent are alive and well.

The technique of multiple weak capsules of radium, each capsule containing approximately 6 mg. per running centimeter, is described by the author. While their statistics are non-convincing due to the limited number of patients treated, theoretically this method should give a better distribution of irradiation and, as indicated in the authors' postoperative specimens, there is less local necrosis with better distribution of the carcinocidal gamma rays. The authors find an improvement in their clinical results when using the multiple capsules as compared to the tandem position for the intrauterine radium. However, other factors also influence their clinical results. These are the histopathological type of the tumor, the biological properties of the tumor, and the size of the uterus.—*George W. Chamberlin, M.D.*

SUBJECT INDEX TO VOLUME 62

(abs) = abstract (E) = editorial

- ABDOMINAL apoplexy (abs), 760
 ABSCESS, submucous, of esophagus (abs), 904
 ACHLORHYDRIA and peptic ulcer (abs), 757
 ACROCEPHALOSYNDACTYLY (abs), 901
 ACROMEGALY, ossification of auricles of external ears associated with (abs), 150
 ADENOCARCINOMA, metastatic, of talus from recto-sigmoid region (abs), 768
 ADENOMA, chromophobe, of pituitary (abs), 904
 ADENOMATOSIS, polypoid, of entire gastrointestinal tract (abs), 449
 pulmonary, with new laboratory finding, 525
 ADRENAL cortical carcinoma, nonhormonal (abs), 453
 medulla, pheochromocytoma of (abs), 761
 ADRENALS of hosts, effect of growth or retrogression of transplantable lymphosarcoma of rat on (abs), 466
 AGED, peptic ulcer in (abs), 288
 AGENESIS of corpus callosum in infancy (abs), 903
 AIR BLOCK, mediastinal, 798
 ALIMENTARY TRACT See Gastrointestinal tract
 ALUMINA abrasives, lung changes associated with manufacture of (abs), 589
 AMERICAN ROENTGEN RAY SOCIETY, annual meeting of (E), 117; (E), 730
 commercial exhibit at 1949 meeting, 742
 hotel reservations for 1949 meeting, 277
 new officers for 1949-1950, 743
 preliminary program for 1949 meeting, 132
 scientific exhibit at 1949 meeting, 736
 Section on Instruction, 1949 meeting, 135
 AMINOPTERIN, temporary remissions in acute leukemia in children produced by (abs), 309
 ANASTOMOSIS, aortic pulmonary, in congenital pulmonary stenosis (abs), 907
 ANATOMICAL variations, roentgen classification of hydronephrosis based on (abs), 454
 ANEMIA, sickle cell, collapse of vertebral bodies in, 395
 ANEURYSM, congenital, of pulmonary artery, diagnosis of (abs), 754
 of ductus arteriosus, postmortem roentgen study after instillation of barium paste, 223
 of lung, congenital arteriovenous, 500
 ANEURYSMS, cerebral arteriovenous, diagnosis and therapy of (abs), 280
 visualization of (abs), 770
 ANGIOCARDIOGRAPHIC aspects of aberrant insertion of pulmonary veins associated with interatrial septal defect, 500
 ANGIOCARDIOGRAPHY, automatic roentgen-ray roll-film magazine for, 355
 diagnosis by, of operability in lung cancer, 737
 diagnosis of pulmonary stenosis by (abs), 591
 diagnosis of syphilitic aortitis by, 655
 studies of pulmonary artery by, 737
 ANGIOGRAPHIC study of pulmonary artery (abs), 285
 ANGIOGRAPHY, cardiovascular, advantages of automatization in, 33
 cerebral, time factor in, 509
 study by, of form and function of remaining lung after pneumonectomy (abs), 754
 ANGIOMATOSIS, encephalotrigeminal, intracranial calcification in, 247
 ANOMALY, unusual, of inferior portion of scapula (abs), 601
 ANTHRACOSILICOSIS (abs), 447
 ANTIGEN sensitivity among student nurses (abs), 751
 AORTA, ascending, calcifications of (abs), 153
 coarctation of (abs), 755
 coarctation of, surgical treatment for (abs), 755
 right arch of, and left ligamentum arteriosum, tracheo-esophageal constriction produced by, 493
 visualization of, and its branches, by retroarterial diodrast injection (abs), 755
 AORTITIS, syphilitic, angiocardio-graphic diagnosis of, 655
 APOPLEXY, abdominal (abs), 760
 APPENDIX, roentgen examination of (abs), 594
 ARGENTAFFINOMA of gastrointestinal tract (abs), 593
Armillifer armillatus, cysts in man due to (abs), 914
 ARTERIES, peripheral, visualization of (abs), 770
 ARTERIOGRAPHY, cerebral, 736
 cerebral, automatic roentgen-ray roll-film magazine for, 355
 in cerebral vascular accidents (abs), 749
 new iodized substance for (abs), 310
 retrograde, in diagnosis of cardiovascular lesions (abs), 770
 ARTERIOVENOUS fistula of lung, syndrome of, 418
 ARTERY, internal carotid, unexplained thrombosis of (abs), 280
 pulmonary, angiographic study of (abs), 285
 pulmonary, diagnosis of congenital aneurysm of (abs), 754
 pulmonary, relationship of roentgenographic appearance of, to pulmonary hemodynamics, 777
 ARTHRITIS, sacroiliac, brucellosis as cause of (abs), 912
 ASTHMA in children, sedimentation rate in (abs), 152
 ATELECTASIS, bilateral pneumothorax associated with, occurring during labor, 798
 ATLANTA RADIOLOGICAL SOCIETY, 277
 ATRESIA, esophageal, congenital tracheo-esophageal fistulas without (abs), 584
 ATROPINE, effect of, on acute irradiation sickness in mice, 547
 AURICLES, ossification of, of external ears associated with acromegaly (abs), 150

- AUTORADIOGRAPHS of C^{14} incorporated in individual blood cells (abs), 772
- Bacillus anthracis*, roentgen treatment of external infections due to (abs), 917
mucosus capsulatus, clinical and roentgen manifestations of pneumonia due to, 211
- BANTI'S SYNDROME, venous calcification in (abs), 458
- BARCLAY, Alfred Ernest, 1877-1949, obituary, 119
 portrait, 119
- BARIUM enema, accidental filling of urinary tract during (abs), 294
 enema, reduction of intussusception by (abs), 594
 paste, postmortem roentgen study of aneurysm of ductus arteriosus after instillation of, 223
- BARROW, Sidney Conroy, 1876-1948, obituary, 569
 portrait, 569
- BASAL METABOLISM, relation of hypophysis to (abs), 902
- BASILAR IMPRESSION, significance of certain measurements of skull in diagnosis of (abs), 584
- BASOPHILISM, pituitary, 1
- BERYLLIUM, delayed chemical pneumonitis or diffuse granulomatosis of lung due to (abs), 590
 worker, delayed pneumonitis in (abs), 285
- BETATRON, development of, for electron therapy (abs), 466
 22 mev., depth dose data and isodose distributions for radiation from, 257, 898
- BILIARY ducts, cholangiography in stone stricture and operative injury of (abs), 910
- BIOLOGICAL effects of roentgen rays of various wavelengths, 252
 evaluation of 20 million volt roentgen rays, 555
- BIRTH WEIGHT, prenatal estimation of, by pelvicocephalometry (abs), 773
- BLADDER, carcinoma of, with bone metastases (abs), 454
 urinary, deformities of, secondary to ureteral stone, 670
 urinary, intravenous urography in study of obstructions of neck of, 661
 urinary, sarcoma of, in children, 843
- BLASTOMYCOSIS, pulmonary (abs), 446
- BLIND, training of, for dark room technicians, 726
- BLOOD cells, individual, autoradiographs of C^{14} incorporated in (abs), 772
 changes in coagulability of, after radiation therapy, 541
 flow through chambers of heart, radiocardiography for studying (abs), 448
 human, effects of irradiation upon chylomicrons in (abs), 774
 venous, rate of flow of, in legs, measured with radioactive sodium (abs), 465
 vessels, aberrant, obstructive hydronephrosis produced by, diagnosis by intravenous urography (abs), 293
- BONE and cartilage debris in synovial membrane (abs), 303
 and joint involvement, miliary, in fatal case of disseminated granuloma inguinale (abs), 157
 and joint lesions in leprosy (abs), 455
 and joint, streptomycin in tuberculosis of (abs), 298
 and skin changes in leg, roentgen study of (abs), 157
 changes in hemophilia (abs), 302
 chondromyxoid fibroma of (abs), 299
 coccidioidal granuloma of, 229
 endothelioma of (abs), 455
 eosinophilic granuloma of (abs), 297; (abs), 914
 formation and estrogens in human female (abs), 608
 formation in skin and muscle (abs), 599
 frontal, cavernous hemangioma of (abs), 901
 giant cell tumors of, comparison between anatomical and roentgen appearance of (abs), 770
 graft, delayed autogenous, in treatment of congenital pseudoarthrosis (abs), 767
 involvement in malignant lymphoma (abs), 297
 irradiated, sarcoma arising in (abs), 464
 late results of radiation therapy of lesions of, 740
 lesions, benign, is roentgen therapy hazardous in? (E), 891
 lesions in eosinophilic granuloma, Hand-Schüller-Christian disease and Letterer-Siwe disease (abs), 600
 lesions, relative incidence of, over thirty-seven year period, 375
 lipomatosis involving (abs), 158
 malignant degeneration of benign giant cell tumor of, 685
 malignant degeneration of giant cell tumors of (abs), 298
 marrow infusions in infants, roentgen findings in osteomyelitis following, 534
 massive hyperplasia of, following fractures of osteogenesis imperfecta (abs), 608
 metastases, carcinoma of bladder with (abs), 454
 metastases in carcinoma of uterine cervix, 741
 metastasis in malignant melanoma, 388
 multiple myeloma and Paget's disease of, treated with stilbamidine (abs), 307
 ossifying fibroma of, roentgen appearance (abs), 456
 pulsating benign giant cell tumors of (abs), 158
 roentgenographic appearance of renal cancer metastasis in (abs), 298
 streptomycin in treatment of chronic infections of (abs), 601
 temporal, roentgenology of (abs), 901
- BONES, long, avascular necrosis of large segmental fracture fragments of (abs), 766
- BOOK REVIEWS
 Neoplasms of Bone and Related Conditions:

- Their Etiology, Pathogenesis, Diagnosis, and Treatment. By Bradley L. Coley, 578
 Management of Common Gastro-intestinal Diseases. Edited by Thomas A. Johnson, 578
 Handbook of Diseases of the Skin. By Richard L. Sutton and Richard L. Sutton, Jr., 579
 An Introduction to Gastro-Enterology. By Walter C. Alvarez, 580
 Bilharzial Cancer: Radiological Diagnosis and Treatment. By Mahmoud Ahmed Afifi, 580
 Histopathology of Irradiation from external and Internal Sources. Edited by William Bloom, 580
 Intracranial Tumors. By Percival Bailey, 745
 The Skull, Sinuses and Mastoids: A Handbook of Roentgen Diagnosis. By Barton R. Young, 745
 Acute Intestinal Obstruction. By Rodney Smith, 746
 BORRMANN typing, prognosis in carcinoma of stomach based on (abs), 291
 BRAIN, cancer of (abs), 294
 necrosis of, due to radiation therapy (abs), 902
 BREAST, cancer of, 335, 345
 cancer of, irradiation in treatment of (abs), 459
 cancer of, treatment by roentgen irradiation combined with Halsted operation (abs), 459
 cancer, roentgen therapy as sole method of treatment, 311
 cancer, treatment and results in, 320, 326, 341, 349
 cancer, treatment and results in, at Presbyterian Hospital, New York, 328
 carcinoma, influence of castration by roentgen irradiation on (abs), 460
 comedomastitis of (abs), 281
 inflammatory carcinoma of (abs), 281
 BRILL-SYMMERS DISEASE (abs), 310
 BRONCHI, malformations of, 177
 BRONCHIAL peristalsis, 65
 tree, visible, roentgen sign in pneumonic and other pulmonary consolidations (abs), 282
 BRONCHOGENIC carcinoma (abs), 285
 carcinoma, non-malignant intrathoracic lesions simulating (abs), 444
 BRONCHOPNEUMONIA, suppurative, with cavitation (abs), 445
 BRUCellosis as cause of sacroiliac arthritis (abs), 912

 C¹⁴, autoradiographs of, incorporated in individual blood cells (abs), 772
 CALCIFICATION, diffuse, of pancreas (abs), 154
 in intraspinal meningiomas, 237
 in suprarenal neoplasms (abs), 596
 intracranial, in encephalotrigeminal angiomas, 247
 of cysts due to *Armillifer armillatus* (abs), 914
 of pancreas (abs), 451
 venous, in Banti's syndrome (abs), 458

 CALCIFICATIONS of ascending aorta (abs), 153
 pulmonary, tuberculin, coccidioidin and histoplasmin sensitivity in relation to (abs), 753
 CALCINOSIS, tumoral (abs), 764
 CALCULI, ureteral, roentgenologic control of, on operating table, 113
 CALDWELL LECTURE, 1947, 1; 1948, 159
 CANCER, endometrial, use of multiple sources of radium within uterus in treatment of (abs), 918
 epidemiological features of (abs), 776
 gastric, mass gastric roentgen surveys for control of, 574
 intraoral, radiation treatment of, 482
 of breast, 335; 345
 of breast, irradiation in treatment of (abs), 459
 of breast, roentgen therapy as sole method of treatment of, 311
 of breast, treatment and results in, 320, 326, 341, 349
 of breast, treatment and results in, at Presbyterian Hospital, New York, 328
 of breast, treatment of, by roentgen irradiation combined with Halsted operation (abs), 459
 of canthi, treatment by radium needles, 479
 of cervix uteri, five year end results of radiation therapy of, at Memorial Hospital (abs), 614
 of face, neck and ear, treatment by radium, 475
 of female pelvis, radiation treatment of, 490
 of larynx (abs), 750
 of larynx, tumor dose in (abs), 459
 of lip, treatment by radiation, 481
 of nervous system (abs), 294
 of pharynx (abs), 904
 of respiratory system in United States chromatoproducing industry (abs), 446
 of uterus, control of (abs), 610
 pelvic, delay in diagnosis of (abs), 155
 pelvic, organization and observations of Philadelphia Committee for Study of (abs), 155
 renal, metastasis in bone, roentgenographic appearance in (abs), 298
 roles of surgery and radiology in treatment of, 858
 uterine, evaluation of vaginal smear method for diagnosis of (abs), 155
 CARBOHYDRATE metabolism, relation of hypophysis to (abs), 902
 CARCINOMA, advanced, complete excision of pelvis viscera for (abs), 461
 and chancre of cervix (abs), 596
 apical pulmonary, and tuberculosis (abs), 590
 bronchiogenic, fate of oil particles in lung and possible relationship to development of, 788
 bronchogenic (abs), 285; (abs), 751
 bronchogenic, non-malignant intrathoracic lesions simulating (abs), 444
 cells in prostatic secretions (abs), 763
 cervical, urinary tract changes in (abs), 763
 completely obstructing annular, of descending

- colon, five year survival rate in cases of (abs), 291
- developing in chronic draining cutaneous sinuses and fistulas (abs), 772
- endometrial, evaluation of adjunctive radiotherapy in surgical treatment of (abs), 614
- gastric, and sarcoma, distinctions between (abs), 592
- inflammatory, of breast (abs), 281
- intraepithelial epidermoid, of cervix, anatomical distribution of (abs), 596
- nonhormonal adrenal cortical (abs), 453
- of bladder with bone metastases (abs), 454
- of breast, influence of castration by roentgen irradiation on (abs), 460
- of cervix, comparison of accuracy in diagnosis of vaginal smear and biopsy (abs), 761
- of cervix, complicating procidentia uteri (abs), 760
- of cervix in urban population (abs), 462
- of cervix, treatment of (abs), 610
- of descending colon, sigmoid and rectosigmoid, intramural extension of (abs), 292
- of endometrium (abs), 773
- of lung, diagnosis of (abs), 753
- of ovary, results of treatment of (abs), 463
- of prostate gland (abs), 598
- of stomach, prognosis based upon Borrmann typing or presence of metastases (abs), 291
- of uterine cervix, radium therapy for (correction), 441
- of uterus, ovary and tube (abs), 461
- primary, of liver in boy aged fifteen (abs), 291
- primary, of lung (abs), 446
- squamous cell, of mouth, histologic changes in, produced by fractionated external roentgen irradiation (abs), 611
- squamous cell, of nail bed (abs), 599
- Stage I, of cervix uteri, management of (abs), 610
- vulvar and cervical, treatment of (abs), 613
- CARDIOVASCULAR angiography, advantages of automatization in, 33
- lesions, retrograde arteriography in diagnosis of (abs), 770
- CARTILAGE debris in synovial membrane (abs), 303
- CASTRATION by roentgen irradiation, influence of, on carcinoma of breast (abs), 460
- CAVITATION, suppurative bronchopneumonia with (abs), 445
- CELIAC SYNDROME (abs), 451
- CELLS, studies on radiosensitivity of (abs), 465
- CEREBRAL angiography, time factor in, 509
- vascular accidents, arteriography in (abs), 749
- CERVIX UTERI, anatomical distribution of intraepithelial epidermoid carcinomas of (abs), 596
- cancer, five year end results of radiation therapy of, at Memorial Hospital (abs), 614
- carcinoma of, comparison of accuracy in diagnosis of vaginal smear and biopsy in (abs), 761
- carcinoma of, complicating procidentia uteri (abs), 760
- carcinoma of, in urban population (abs), 462
- carcinoma of, urinary tract changes in (abs), 763
- carcinoma, treatment of (abs), 610; (abs), 613
- chancre and carcinoma of (abs), 596
- radium therapy for carcinoma of (correction), 441
- Stage I carcinoma, management of (abs), 610
- CHANCRE and carcinoma of cervix (abs), 596
- CHARCOT JOINT, multiple, 531
- CHEMOTHERAPY in lymphomas, leukemias and allied disorders of hemopoietic system (abs), 612
- of neoplastic disease (abs), 613
- symptoms masked or modified by (abs), 608
- CHEST See also THORAX
- clinic, diagnostic fluoroscopy at (abs), 282
- report on community-wide roentgen survey of, at Minneapolis, Minnesota (abs), 585
- roentgen appearance of, in diseases affecting peripheral vascular system of lungs (abs), 906
- solitary tumors of, 52
- CHILD, extreme hypertension in, cured by nephrectomy (abs), 761
- mesenteric lipoma in (abs), 910
- CHILDREN, intussusception in (abs), 594
- male, urethrocytography in (abs), 452
- mucosal pattern of terminal ileum in (abs), 911
- roentgen diagnosis of rickets associated with other skeletal diseases of (abs), 455
- sarcoma of urinary bladder in, 843
- sedimentation rate in asthma in (abs), 152
- temporary remissions in acute leukemia in, produced by folic acid antagonist (abs), 309
- urethrography in (abs), 762
- value of routine roentgenograms of wrist in (abs), 912
- CHOLANGIOGRAPHY in stone stricture and operative injury of biliary ducts (abs), 910
- operative, routine use of (abs), 451
- routine operative, 738
- CHOLECYSTITIS, acute gaseous (abs), 287
- emphysematous, 814
- CHOLESTEATOMA of middle ear, roentgen diagnosis of, 674
- CHONDROMA of larynx, 715
- CHONDROMYXOID fibroma of bone (abs), 299
- CHROMATE-PRODUCING industry, cancer of respiratory system in (abs), 446
- CHYLOMICRONS in human blood, effects of irradiation upon (abs), 774
- CINCINNATI RADIOLOGICAL SOCIETY, 899
- CIRCULATION, studies of, by roentgen cinematography (abs), 458
- COAGULABILITY of blood, changes in, after radiation therapy, 541
- COARCTATION of aorta (abs), 755
- of aorta, surgical treatment for (abs), 755

- COCCIDIOIDAL granuloma of bone, 229
- COCCIDIOIDIN sensitivity in relation to pulmonary calcifications (abs), 753
- COCCIDIOIDOMYCOSIS (abs), 771
pathogenesis of, with special reference to pulmonary cavitation (abs), 588
- COLITIS, chronic nonspecific ulcerative, clinical course of (abs), 154
chronic ulcerative, involvement of ileum in (abs), 759
idiopathic ulcerative (abs), 759
- COLLAPSE, spontaneous of lung (abs), 590
- COLON, descending, completely obstructing annular carcinoma of, five year survival rate in cases of (abs), 291
descending, intramural extension of carcinoma of (abs), 292
extrinsic deformities of (abs), 911
myenteric plexus in congenital megacolon (abs), 287
partly duplicated, 855
roentgen diagnosis of malignant and potentially malignant lesions of (abs), 911
roentgenologic examination of, 737
- COMEDOMASTITIS, clinical and pathologic study of (abs), 281
- CONGENITAL absence of gallbladder (abs), 760
arteriovenous aneurysm of lung, 500
cystic disease of lung (E), 567
cystic malformation of lung, differential diagnosis and treatment (abs), 587
megacolon, myenteric plexus in (abs), 287
megaloureter and hydroureter, pathogenesis and classification (abs), 293
obstructions of respiratory tract, 167, 177
pulmonary cyst, tension type of (abs), 587
tracheo-esophageal fistulas without esophageal atresia (abs), 584
- CONGRESS OF RADIOLOGY, Sixth International (E), 270
- CONJUNCTIVA, lymphoma of (abs), 280
- CONSTRICTION, tracheo-esophageal, produced by right aortic arch and left ligamentum arteriosum, 493
- CONTRAST MEDIA for roentgen diagnoses, iodinated organic compounds as (abs), 773
- COR PULMONALE, lipoid granulomatosis with (abs), 284
- CORPUS CALLOSUM, agenesis of, in infancy (abs), 903
- CORACOCALVICULAR joint, surgical treatment of painful syndrome caused by anomalous joint (abs), 300
- CORONOID process, restricted jaw motion due to osteochondroma of (abs), 764
- COXA magna following synovitis of hip joint (abs), 158
plana (abs), 301
vara, congenital (abs), 768
vara, developmental (abs), 603
- CRANIOCLACUNIA (abs), 280
- CRANIUM, defects of, due to diploic epidermoid and extradural pneumatocele (abs), 151
intracranial calcification in encephalotrigeminal angiomas, 247
- CURLING of esophagus, effect of certain drugs on, 807
- CUSHING'S DISEASE, 1
- CYCLOTRON-PRODUCED radioisotopes, distribution program for, 440
- CYST, congenital pulmonary, tension type of (abs), 587
gastric, of mediastinum (abs), 750
- CYSTIC disease, congenital, of lung (E), 567
malformation, congenital, of lung, differential diagnosis and treatment (abs), 587
- CYSTITIS emphysematosa (abs), 587
- CYSTOSCOPY, twelfth human case of cystitis emphysematosa diagnosed by (abs), 587
- CYSTS, calcification of, due to *Armillifer armillatus* (abs), 914
spinal extradural (abs), 605
vertebral echinococcus, roentgen study of (abs), 604
- DARK ROOM technicians, training of blind for, 726
- DEATH, sudden, following intravenous administration of diodrast (abs), 776
- DEFICIENCY pattern, small intestinal (abs), 593
- DEGENERATION, malignant, of benign giant cell tumor of bone, 685
- DEPILATION, temporary, for tinea capitis, roentgen therapy for producing (abs), 458
- DESMOID tumors, extra-abdominal (abs), 460
- DIABETICS, degenerative disease in, 742
- DIAPHRAGM, elevated, basal pleural fluid accumulations resembling (abs), 284
lesions of, 185
ulcer associated with hernia of, 368
- DIAPHYSEAL dysplasia, progressive (abs), 455
- DIFFRACTION, roentgen-ray, electron and neutron (abs), 466
- DILATATION of jejunum, 831
- DIODONE, viscous, as substitute for iodized oil (abs), 773
- DIODRAST injection, retroarterial, visualization of aorta and branches by (abs), 755
sudden death following intravenous administration of (abs), 776
use of, in intravenous urography in study of vesical neck obstructions, 661
- DISLOCATION of head of fibula (abs), 602
posterior, of shoulder joint (abs), 601
traumatic posterior, of humerus (abs), 765
- DIVERTICULUM, dissecting (intramural) pharyngo-esophageal (abs), 153
- DIVERTICULA, duodenal, surgical and roentgenological aspects of (abs), 593
- DONOVAN, Monica, 1892-1948, obituary, 570
- DOSE, depth, data for radiation from a 22 mev. beta-tron, 257, 898
tumor, in cancer of larynx (abs), 459

- Drosophila melanogaster*, recessive sex-linked lethals in, 555
- DRUGS, common gastric, effect of, on motility of stomach (abs), 153
effect of certain, on curling of esophagus, 807
- DUCTUS ARTERIOSUS, aneurysm of, with postmortem roentgen study after instillation of barium paste, 223
- DUODENUM, diverticula of, surgical and roentgenologic aspects of (abs), 593
results following subtotal gastrectomy for ulcer of (abs), 290
statistical study of life cycle of 1,154 cases of ulcer of (abs), 288
- DYSCHONDROPLASIA (abs), 607
- DYSOSTOSIS of skull, face and extremities (abs), 901
- DYSPLASIA, fibrous (abs), 769
- EAR, middle, roentgen diagnosis of cholesteatoma of, 674
- EARS, external, ossification of auricles of, associated with acromegaly (abs), 150
- EASTERN CONFERENCE OF RADIOLOGISTS, announcement of 1950 meeting, 744
- EDEMA, pulmonary (abs), 909
pulmonary, bilateral pneumothorax associated with, occurring during labor, 798
transient pulmonary, with hemoptosis (abs), 282
- EDITORIALS
The annual meeting of the American Roentgen Ray Society, 117
Alfred Ernest Barclay, 1877-1949, 119
Henry Hulst, 1859-1949, 126
Sixth International Congress of Radiology, 270
J. Ernest Gendreau, 1880-1949, 272
Ludwig Halberstaedter, 1877-1949, 273
Mineral oil pneumonitis, 433
Anders Peter Overgaard, 1879-1948, 435
Congenital cystic disease of the lung, 567
Sidney Conroy Barrow, 1876-1948, 569
Monica Donovan, 1892-1948, 570
The annual meeting of the American Roentgen Ray Society, 730
Arial Wellington George, 1882-1948, 732
Is roentgen therapy hazardous in benign bone lesions?, 891
John Remer, 1862-1949, 894
- EFFECT of atropine on acute irradiation sickness in mice, 547
- EFFECTS, biological, of roentgen rays of various wavelengths, 252
lethal, of total roentgen irradiation in triton, time factor in, 550
neutron and roentgen-ray on protein content of rat intestine, 718
neutron, on alkaline phosphatase of rat intestine, 723
of irradiation upon chylomicrons in human blood (abs), 774
radiation, on 2,3,5-triphenyltetrazolium chloride solutions, 559
- EFFUSION, pleural, and idiopathic pleurisy, relation of, to tuberculosis (abs), 908
- ELECTRON diffraction (abs), 466
therapy, development of betatron for (abs), 466
- ELECTRONS, fast, therapeutic principles of (abs), 466
- EMPHYSEMA, mediastinal, 737
subcutaneous, bilateral pneumothorax associated with, occurring during labor, 798
- EMPHYSEMATOUS cholecystitis, 814
- EMPYEMA (abs), 591
- ENCHONDROMAS, multiple (abs), 607
- ENDOMETRIOSIS, pelvic, treatment of (abs), 461
- ENDOMETRIUM, carcinoma (abs), 773
carcinoma, evaluation of adjunctive radiotherapy in surgical treatment of (abs), 614
- ENDOTHELIOMA of bone (abs), 455
- EPIDERMOID, diploic, cranial defects due to (abs), 151
intraventricular, pneumographic diagnosis of (abs), 150
- EPILEPSY, focal (abs), 150
focal, correlation of pathological and roentgen findings (abs), 279
- EPIPHYSIS, nailed slipped capital femoral, roentgen changes in (abs), 765
survival and growth of, after removal and replacement (abs), 766
- ESOPHAGUS, effect of certain drugs on curling of, 807
lower, stricture of, caused by scleroderma, 359
spontaneous rupture of (abs), 584
submucous abscess of (abs), 904
- ESTROGENS and bone formation in human female (abs), 608
- EXOPHTHALMOS, pulsating, due to defective development of sphenoid bone, 44
- EXTREMITIES, dysostosis of (abs), 901
- FACE, dysostosis of (abs), 901
- FACSIMILE, roentgenographic, 741
- FALLOPIAN TUBE, carcinoma of (abs), 461
- FEMUR, intracapsular fracture of, treated with combined Smith-Petersen nail and fibular graft (abs), 767
treatment of necrotic head of, in adults (abs), 767
- FETAL death, roentgen demonstration of, and uterine rupture, 837
- FIBROCYSTIC disease of pancreas (abs), 910
- FIBROMA, chondromyxoid, of bone (abs), 299
ossifying, of bone, roentgen appearance (abs), 456
- FIBROSIS, acute diffuse interstitial, of lungs (abs), 906
- FIBULA, dislocation of head of (abs), 602
- FISTULA, arteriovenous, of lung, syndrome of, 418
gastrojejunal (abs), 758
- FISTULAS, carcinoma developing in (abs), 772
congenital tracheo-esophageal, without esophageal atresia (abs), 584

- FLAT FOOT, peroneal spastic, etiology of (abs), 606
- FOLIC ACID antagonist, temporary remissions in acute leukemia in children produced by (abs), 309
- FRACTURE, bilateral, of pars interarticularis of lumbar neural arch (abs), 605
isolated, of pisiform bone (abs), 296
- FRACTURES, intracapsular, of femur treated with combined Smith-Petersen nail and fibular graft (abs), 767
of osteogenesis imperfecta, massive hyperplasia of bone following (abs), 608
sideswipe (abs), 157
- FUNCTIONAL disturbances of gastrointestinal tract, roentgen findings in (abs), 448
- GALLBLADDER, congenital absence of (abs), 760
double (abs), 595
pathological (abs), 909
- GALLSTONE, silent (abs), 595
- GARGOYLISM, study of pathologic lesions of (abs), 916
- GASTRECTOMY, subtotal, for duodenal and gastric ulcer, results following (abs), 290
- GASTROINTESTINAL TRACT, argentaffinoma of (abs), 593
lipomas of, 823
obstruction of, in infancy (abs), 448; 738
polypoid adenomatosis of entire (abs), 449
roentgen findings in functional disturbances of (abs), 448
roentgen observations of, in post vagotomy, 738
- GASTROSCOPIC appearances following vagotomy (abs), 756
- GAUCHER'S DISEASE, aseptic necrosis in (abs), 300
- GENDREAU, J. Ernest, 1880-1949, obituary, 272
- GEORGE, Arial Wellington, 1882-1948, obituary, 732
portrait, 732
- GLOMUS tumors, roentgen diagnosis of (abs), 903
- GOITER, exophthalmic, anomalous action of Lugol's solution in (abs), 151
- GRADUATE education in radiology, 159
- GRANULOMA, coccidioidal, of bone, 229
eosinophilic, bone lesions in (abs), 600
eosinophilic, of bone (abs), 297; (abs), 914
inguinale, disseminated, pathologic findings in fatal case of (abs), 157
- GRANULOMATOSIS, diffuse, of lung due to beryllium (abs), 590
lipoid, with marked pulmonary fibrosis and cor pulmonale (abs), 284
reticulo-endothelial (abs), 915
- GREATER MIAMI RADIOLOGICAL SOCIETY, 898
- HALBERSTAEDTER, Ludwig, 1877-1949, obituary, 273
- HALSTED operation, treatment of cancer of breast by roentgen irradiation combined with (abs), 459
- HAND-SCHÜLLER-CHRISTIAN DISEASE, 189; (abs), 915
bone lesions in (abs), 600
- HEART, differential diagnosis of retrocardiac shadows (abs), 286
radiocardiography for studying blood flow through chambers of (abs), 448
- HEMANGIOMA, cavernous, of frontal bone (abs), 901
- HEMATOMAS, ossifying, mistaken for sarcoma (abs), 599
- HEMODYNAMICS, pulmonary relationship of roentgenographic appearance of pulmonary artery to, 777
- HEMOPHILIA, bone and joint changes in (abs), 302
- HEMOPOIETIC SYSTEM, disorders of, chemotherapy of (abs), 612
disorders of, external irradiation with roentgen rays and radium in treatment of (abs), 612
- HERNIA, diaphragmatic, ulcer associated with, 368
femoral, stomach in (abs), 591
of diaphragm, 185
of lumbar intervertebral disc, diagnosis and treatment (abs), 305
- HIP, results of open reduction of true congenital luxation of (abs), 602
tuberculosis of, evolution and treatment (abs), 454
- HIPS, congenitally dislocated, laminagraphy through plaster casts in postreduction roentgenography of (abs), 465
- HIRSCHSPRUNG'S DISEASE, etiology and surgical treatment of, 738
- HISTOPLASMIN sensitivity in relation to pulmonary calcifications (abs), 753
- HODGKIN'S DISEASE (abs), 308
and allied disorders, diagnosis, treatment and prognosis of (abs), 308
external irradiation with roentgen rays and radium in treatment of (abs), 612
skeletal lesions in (abs), 769
use of nitrogen mustard in (abs), 771
- HULST, HENRY, 1859-1949, obituary, 126
portrait, 126
- HUMERUS, traumatic posterior dislocation of (abs), 765
- HYDRONEPHROSIS, obstructive, produced by aberrant blood vessels, diagnosis by intravenous urography (abs), 293
roentgen classification based on anatomical variations (abs), 454
- HYDROURETER, congenital, pathogenesis and classification (abs), 293
- HYGROMAS, cervicomediastinal and mediastinal cystic (abs), 286
- HYPERPARATHYROIDISM, surgical aspects of (abs), 443
- HYPERTENSION, extreme, in child cured by nephrectomy (abs), 761
- HYPOPHOSPHATASIA (abs), 913
- HYPOPHYSECTOMIZED rat, irradiation of (abs), 775
- HYPOPHYSIS, relation of, to carbohydrate and basal metabolism (abs), 902

- ILEUM, involvement of, in chronic ulcerative colitis (abs), 759
terminal, mucosal pattern of, in children (abs), 911
- ILEUS, meconium, therapy of (abs), 451
- INCOME-SHARING formula, basis for paying part time pathologists and radiologists (abs), 609
- INDUSTRIAL pulmonary disease, pathogenesis of (abs), 589
- INFANTS, agenesis of corpus callosum in (abs), 903
obstructions of alimentary tract in (abs), 448
primary pneumonitis in (abs), 752
roentgen diagnosis of rickets associated with other skeletal diseases of (abs), 455
roentgen findings in osteomyelitis following bone marrow infusions in, 534
sacroccygeal teratomas in (abs), 307
urethrography in (abs), 762
- INFARCTS, multiple pulmonary, nodular pulmonary densities due to scars of, 208
- INFECTIONS, chronic, of bone, streptomycin in treatment of (abs), 601
external, due to *Bacillus anthracis*, roentgen treatment of (abs), 917
roentgen rays in prevention and treatment of (abs), 917
- INTENSIFICATION SYSTEMS, screen, 617
screen, clinical potentialities of, 635
- INTERVERTEBRAL DISC, lumbar, diagnosis and treatment of hernia of (abs), 205
protrusion, myelography in (abs), 304
- INTERVERTEBRAL DISCS, displaced, correlation of neurologic, orthopedic and roentgenographic findings (abs), 304
- INTESTINE, rat, neutron and roentgen-ray effects on protein content of, 718
small, deficiency pattern of (abs), 593
small, primary malignant disease of (abs), 911
- INTRA-AVEOLAR pressure, importance of, in diagnosis of pulmonary disease (abs), 445
- INTRAORAL roentgenography, extended tube technique in, 881
- INTRATHORACIC See THORAX
- INTUSSUSCEPTION in childhood (abs), 594
reduction of, by barium enema (abs), 594
- IODINATED organic compounds as contrast media for roentgen diagnoses (abs), 773
- IODIZED oil, viscous diodone as substitute for (abs), 773
substance, new, for arteriography and phlebography (abs), 310
- IRRADIATION, effects of, upon chylomicrons in human blood (abs), 774
sickness, acute, in mice, effect of atropine on, 547
- ISODOSE distributions for radiations from a 22 mev. betatron, 257
- JANEWAY LECTURE, 1949, 467
- JAW, restricted motion of, due to osteochondroma of coronoid process (abs), 764
- JEJUNITIS, regional (abs), 287
- JEJUNUM, dilatation of, 831
- JOINT changes in hemophilia (abs), 302
coracoclavicular (abs), 300
lesions in leprosy (abs), 455
- JOINTS, Charcot, multiple, 531
streptomycin in tuberculosis of (abs), 298
- Journal of Faculty of Radiologists*, new journal, 577
- KELOIDS and hypertrophic scars (abs), 609
- KIDNEY, leukoplakia of pelvis of (abs), 597
lymphosarcoma of (abs), 761
posteriorly located pelvis of, associated with ptosis (abs), 293
- KIDNEYS, cysts of, 739
ptosis of, treatment (abs), 597
radiation therapy for Wilms' tumor of (abs), 918
- KINGS COUNTY RADIOLOGICAL SOCIETY, 277
- KIRKLIN, B. R., Caldwell Lecturer, 1948, portrait opposite page 159
- KNEE joint changes after meniscectomy (abs), 602
pneumoarthrography of, newer methods (abs), 295
- LABOR, bilateral pneumothorax occurring during, 798
- LAMINAGRAPHY in diagnosis of less common diseases of larynx (abs), 584
through plaster casts in postreduction roentgenography of congenitally dislocated hips (abs), 465
- LARYNX, cancer of (abs), 750
cancer, tumor dose in (abs), 459
chondroma of, 715
stratigraphy in diagnosis of less common diseases of (abs), 584
- LEG concurrent skin and bone changes in, roentgen study of (abs), 157
- LEGS, rate of flow of venous blood in, measured with radioactive sodium (abs), 465
- LEPROSY, bone and joint lesions in (abs), 455
- LESIONS of diaphragm, 185
- LETTERER-SIWE DISEASE, 189
bone lesions in (abs), 600
- LEUKEMIA, acute, in children, temporary remissions produced by folic acid antagonist (abs), 309
chemotherapy in (abs), 612
chronic, of long duration (abs), 309
external irradiation with roentgen rays and radium in treatment of (abs), 612
newer nitrogen mustards in treatment of (abs), 464
- LEUKOPLAKIA of renal pelvis (abs), 597
- LIGAMENTUM ARTERIOSUM, left, and right aortic arch, tracheo-esophageal constriction produced by, 493
- LIPOMA, mesenteric, in child (abs), 910
- LIPOMAS of gastrointestinal tract, 823
- LIPOMATOSIS involving bone (abs), 158
- LITHIASIS, pancreatic (abs), 451

- LIVER**, primary carcinoma of, in boy aged fifteen (abs), 291
- LUGOL'S SOLUTION**, anomalous action of, in exophthalmic goiter (abs), 151
- LUMBOSACRAL** articulation, roentgenologic and clinical study (abs), 306
- LUNG**, congenital arteriovenous aneurysm of, 500
remaining, after pneumonectomy, angiographic study of form and function of (abs), 754
- LUNGS**, acute diffuse interstitial fibrosis of (abs), 906
adenomatosis of, with new laboratory finding, 525
alterations in thoracic cage in diagnosis of tumors of (abs), 590
blastomycosis of (abs), 446
captive, 736
carcinoma of, diagnosis (abs), 753
cavitation of, in coccidioidomycosis (abs), 588
changes in, associated with manufacture of alumina abrasives (abs), 589
coin-like lesions of, 736
congenital cystic disease of (E), 567
congenital cystic malformation of, differential diagnosis and treatment (abs), 587
delayed chemical pneumonitis or diffuse granulomatosis of, due to beryllium (abs), 590
edema of (abs), 909
fate of oil particles in, and possible relationship to development of bronchiogenic carcinoma, 788
importance of intra-alveolar pressure in diagnosis of disease of (abs), 445
lipoid granulomatosis with marked fibrosis of (abs), 284
localization of densities of, from posteroanterior roentgenograms, 737
multiple densities in, differential diagnosis of (abs), 282
nodular densities of, due to scars of multiple pulmonary infarcts, 208
parasitic infection of (abs), 588
pathogenesis of industrial disease of (abs), 589
primary carcinoma of (abs), 446
relationship of roentgenographic appearance of pulmonary artery to pulmonary hemodynamics, 777
roentgen appearance of chest in diseases affecting peripheral vascular system of (abs), 906
roentgen changes in, in infectious mononucleosis, 648
spontaneous collapse of (abs), 590
studies of findings in, among student nurses (abs), 751
syndrome of arteriovenous fistula of, 418
tuberculin coccidioidin and histoplasma sensitivity in relation to calcifications in (abs), 753
tumors of, 736
visible bronchial tree a roentgen sign in consolidations of (abs), 282
- LUXATION**, true congenital, of hip, results of open reduction of (abs), 602
- LYMPH NODES**, cervical, tuberculosis of (abs), 749
- LYMPHADENOPATHY**, significance of giant follicular (abs), 310
- LYMPHATIC SYSTEM**, connections of spinal subarchnoid space with (abs), 294
- LYMPHOBLASTOMAS**, mediastinal, surgical removal of unsuspected (abs), 444
- LYMPHOID** organs, effect of growth or retrogression of transplantable lymphosarcoma of rat on (abs), 466
tumors (abs), 308
- LYMPHOMA**, chemotherapy in (abs), 612
external irradiation with roentgen rays and radium in treatment of (abs), 612
malignant, bone involvement in (abs), 297
malignant, retrosternal infiltration in (abs), 905
of conjunctiva (abs), 280
- LYMPHOSARCOMA**, external irradiation with roentgen rays and radium in treatment of (abs), 612
of kidney (abs), 761
transplantable, of rat, effect of growth or retrogression of, on lymphoid organs and adrenals of hosts (abs), 466
use of nitrogen mustard in (abs), 771
- MALIGNANT** disease of colon and rectum, roentgen diagnosis of (abs), 911
disease, primary, of small intestine (abs), 911
diseases, nitrogen mustard as systemic adjunct to radiation therapy of (correction), 441
- MARTIN**, Charles L., Janeway Lecturer, 1949, portrait opposite page 467
- MEDIASTINITIS** anterior chronica (abs), 905
- MEDIASTINUM**, cystic hygromas of (abs), 287
gastric cyst of (abs), 750
lesions of, 737
tumors of (abs), 750
unsuspected lymphoblastomas of, surgical removal of (abs), 444
- MEDICINE**, clinical, relation of therapeutic radiology, to, 75
- MEGACOLON**, congenital, myenteric plexus in (abs), 287
- MEGADUODENUM**, idiopathic (abs), 758
- MEGALOURETER**, congenital, pathogenesis and classification (abs), 293
- MELANOMA**, malignant, bone metastasis in, 388
- MELORHEOSTOSIS** (abs), 457
- MENINGIOMAS**, intraspinal, calcification in, 237
- MENINGOCELE**, lateral intrathoracic (abs), 287
- MENISCECTOMY**, knee joint changes after (abs), 602
- MESENTERY**, lipoma of, in child (abs), 910
- METASTASES**, bone, carcinoma of bladder with (abs), 454
prognosis in carcinoma of stomach based upon presence of (abs), 291
to talus from rectosigmoid region (abs), 768
- METASTASIS**, bone, in malignant melanoma, 388

- generalized, from sarcoma of uterus (abs), 615
renal cancer, in bone, roentgenographic appearance in (abs), 298
- MICE, effect of atropine on acute irradiation sickness in, 547
- MINERAL OIL pneumonitis (E), 433
- MONIODOTYROSINE, formation of, from radioiodine in thyroid of rat and man (abs), 774
- MONONUCLEOSIS, infectious, 645
- MOUTH, histologic changes in squamous cell carcinoma of, produced by fractionated external roentgen irradiation (abs), 611
- MUCOSA, gastric, new method of examination of, by oil contrast, 564
gastric, prolapse of (abs), 153
redundant gastric, prolapse of (abs), 757
- MUCOSAL pattern of terminal ileum in children (abs), 911
- MUSCLE, bone formation in (abs), 599
- MYELITIS, radiation, of cervical spinal cord (abs), 917
- MYELOGRAPHY in intervertebral disc protrusion (abs), 304
- MYELOMA, multiple, and Paget's disease of bone treated with stilbamidine (abs), 307
multiple, treatment of, with stilbamidine (abs), 917
multiple, urethane therapy in, 742
- MYENTERIC plexus in congenital megacolon (abs), 287
- MYXOCHONDROSARCOMA of talus (abs), 307
- NAIL BED, squamous cell carcinoma of (abs), 599
- NASOPHARYNX, malignant plasmocytoma of (abs), 443
malignant tumors of (abs), 151
- NECROSIS, aseptic, in Gaucher's disease (abs), 300
avascular, of large segmental fracture fragments of long bones (abs), 766
of brain due to radiation therapy (abs), 902
- NEO-IOPAX, rapid method of injecting, in pyelography, 84
- NEOPLASMS See TUMORS
- NEOPLASTIC DISEASE, chemotherapy of (abs), 613
- NEPHRECTOMY, extreme hypertension in child cured by (abs), 761
- NEPHROMA, mesoblastic, in adults (abs), 597
- NERVES, peripheral, cancer of (abs), 295
- NERVOUS SYSTEM, cancer of (abs), 294
- NEURAL ARCH, lumbar, bilateral fracture of pars interarticularis of (abs), 605
- NEURO-ARTHROPATHY, significance of bone and cartilage debris in synovial membrane, in early diagnosis of (abs), 303
- NEUTRON diffraction (abs), 466
effects on alkaline phosphatase of rat intestine, 723
effects on protein content of rat intestine, 718
- NEW YORK ROENTGEN SOCIETY, 277
- NITROGEN mustard as systemic adjunct to radiation therapy of malignant diseases (correction), 441
mustard therapy, clinical experience with (abs), 916
mustard, use of, in Hodgkin's disease and lymphosarcoma (abs), 771
mustards, clinical use (abs), 464
mustards, newer, in treatment of leukemia (abs), 464
- NORTHERN CALIFORNIA RADIOLOGICAL CLUB, 899
- NUCLEUS PULPOSUS, protruded, criteria for spine fusion following removal of (abs), 605
- NURSES, student, studies of pulmonary findings and antigen sensitivity among (abs), 751
- OBSTRUCTIONS, congenital, of respiratory tract, 167, 177
of alimentary tract in infancy (abs), 448
ureteropelvic, symptoms and treatment (abs), 292
vesical neck, intravenous urography in study of, 661
- OCCUPATIONAL history, significance of, in diagnosis of silicosis (abs), 447
- OIL contrast, new method of examination of gastric mucosa, 564
particles in lung and possible relationship to development of bronchiogenic carcinoma, 788
- OLLIER'S DISEASE (abs), 607
- ORCHIECTOMY, radical, for tumors of testis (abs), 460
- OREGON RADIOLOGICAL SOCIETY, 899
- OSSIFICATION of auricles of external ears associated with acromegaly (abs), 150
- OSTEITIS PUBIS, diagnosis and treatment (abs), 763
- OSTEO-ARTHROPATHY, chronic idiopathic hypertrophic (abs), 456
- OSTEOCHONDROMA of coronoid process, restricted jaw motion due to (abs), 764
- OSTEODYSTROPHY, renal (abs), 156
- OSTEOGENESIS IMPERFECTA, fractures of, massive hyperplasia of bone following (abs), 608
- OSTEOMYELITIS following bone marrow infusions in infants, roentgen findings in, 534
- OSTEOPATHIES, atrophic (abs), 297
- OSTEOPETROSIS (abs), 913
- OSTEOPOIKILOSI (abs), 457
- OVARY, carcinoma of (abs), 461
carcinoma, results of treatment of (abs), 463
malignant tumors of (abs), 760
- OVERGAARD, Anders Peter, 1879-1948, obituary, 435
portrait, 435
- PAGET'S DISEASE of bone and multiple myeloma treated with stilbamidine (abs), 307
- PANCREAS, diffuse calcification of (abs), 154
fibrocystic disease of (abs), 910
lithiasis and calcification of (abs), 451
- PANCREATITIS, recurrent acute (abs), 595
- PARANGLIOMA (abs), 598

- PARASITIC infection of lung (abs), 588
- PARS INTERARTICULARIS of lumbar neural arch, bilateral fracture of (abs), 605
- PEDIATRIC roentgenology, continuation course in, 441
- PELVIC cancer delay (abs), 155
- PELVICEPHALOMETRY, prenatal estimation of birth weight by (abs), 773
- PELVIMETER, simple, to be used with triangulation method of pelvimetry (abs), 773
- PELVIS, maternal, value of upright roentgenograms of, at or near term, 707
treatment of endometriosis of (abs), 461
viscera, complete excision of, for advanced carcinoma (abs), 461
- PENDERGRASS, Eugene P., visiting professor of radiology at University of Louisville School of Medicine, 744
- PENICILLIN, radioactive, absorption and excretion studies with (abs), 465
- PEPTIC ULCER, and achlorhydria (abs), 757
and pregnancy (abs), 592
associated with diaphragmatic hernia, 368
bleeding, surgery in (abs), 450
complications of (abs), 290
in aged, onset of (abs), 288
perforating, of lesser curvature, undergoing malignant changes, acute coronary thrombosis in (abs), 754
present status of vagotomy in (abs), 756
results following subtotal gastrectomy for (abs), 290
results of surgical treatment for (abs), 289
results of vagus nerve resections in treatment of (abs), 289
- PERIARTERITIS NODOSA, unusual ureterograms in case of (abs), 453
- PERICARDITIS, chronic constrictive (abs), 905
- PERICARDIUM, chronic diseases of (abs), 905
- PERISTALSIS, bronchial, 65
- PHARYNX, malignant disease of (abs), 904
- PHEOCHROMOCYTOMA of adrenal medulla (abs), 761
- PHLEBOGRAPHY, new iodized substance for (abs), 310
- PHOSPHATASE, alkaline, of rat intestine, neutron effects on, 723
- PHYSICAL factors controlling diagnostic quality of roentgen images, 870
- PHYSICS and radiology, 79
- PISIFORM bone, isolated fracture of (abs), 296
- PITTSBURGH ROENTGEN SOCIETY, 899
- PITUITARY basophilism, 1
gland, chromophobe adenoma of (abs), 904
gland tumors, origin and meaning of (abs), 903
- PLACENTA PRAEVIA, value of upright roentgenograms of maternal pelvis in, 707
- PLANIGRAMS, evaluation of, in pulmonary tuberculosis, 402
- PLASMOCYTOMA, malignant, of nasopharynx (abs), 443
- PLEOCHROMOCYTOMA (abs), 598
- PLEURAL fluid, basal, accumulations of resembling elevated diaphragms (abs), 284
- PLEURISY, idiopathic, relation of, and pleural effusion, to tuberculosis (abs), 908
- PNEUMATOCELE, extradural, cranial defects due to (abs), 151
- PNEUMOARTHROGRAPHY of knee, newer methods of (abs), 295
- PNEUMOGRAPHIC diagnosis of intraventricular epidermoid (abs), 150
- PNEUMOMEDIASTINUM, bilateral pneumothorax associated with, occurring during labor, 798
study of roentgen anatomy of normal thymus with (abs), 586
- PNEUMONECTOMY, angiographic study of form and function of remaining lung after (abs), 754
- PNEUMONIA, clinical and roentgen manifestations of, due to *Bacillus mucosus capsulatus*, 211
primary atypical, roentgenographic course, complications, recovery rate and end results (abs), 151
primary Friedländer, 211
- PNEUMONITIS, chronic nonspecific suppurative (abs), 445
delayed chemical, of lung⁷ due to beryllium (abs), 590
delayed, in beryllium worker (abs), 285
mineral oil (E), 433
primary, in infancy (abs), 752
- PNEUMOTHORAX, bilateral, case of, associated with pneumomediastinum, atelectasis, pulmonary edema and subcutaneous emphysema occurring during labor, 798
- POPULATION, urban, carcinoma of cervix in (abs), 462
- PORPHYRIA, cause of neuromuscular small intestinal disturbance, 739
- PREGNANCY, peptic ulcer and (abs), 592
- PROCIDENTIA UTERI, carcinoma of cervix complicating (abs), 760
- PROLAPSE of gastric mucosa (abs), 153
- PROMIZOLE, treatment of miliary tuberculosis with (abs), 152
- PROSTATE GLAND, carcinoma cells in secretions of (abs), 763
carcinoma of (abs), 598
- PROTECTION against roentgen and beta rays, lead glass fabric for, 740
- PROTEIN content of rat intestine, neutron and roentgen-ray effects on, 718
- PSEUDARTHROSIS, congenital, delayed autogenous bone graft in treatment of (abs), 767
statistical considerations (abs), 912
- PTOSIS, posteriorly located renal pelvis associated with (abs), 293¹
renal, treatment of (abs), 597
- PYELOGRAPHY by rapid injection, 84
excretory, effective compression in (abs), 452
- QUALITY, diagnostic, of roentgen images, physical factors controlling, 870

- RADIATION** effects on 2,3,5-triphenyltetrazolium chloride solutions, 559
 from a 22 mev. betatron, depth dose data and isodose distributions for, 257
 from 22 mev. betatron, depth dose data for, 898
 myelitis of cervical spinal cord (abs), 917
 reduction of undesirable by-effects in products treated by (abs), 775
 therapy, changes in coagulability of blood after, 541
- RADIOACTIVE** penicillin, absorption and excretion studies with (abs), 465
 sodium, rate of flow of venous blood in legs measured with (abs), 465
 tracers, application of, to localization and differential diagnosis of various lesions, 740
- RADIOACTIVITY** and urinary tract calculi (abs), 772
 measuring cup, improved (abs), 465
- RADIOCARDIOGRAPHY**, new method for studying blood flow through chambers of heart (abs), 448
- RADIOIODINE**, formation of monoiodotyrosine from, in thyroid of rat and man (abs), 774
- RADIOISOTOPE** techniques courses, 898
- RADIOISOTOPES** as tracers, courses in technique of using, 743
 cyclotron-produced, distribution program for, 440
- RADIOLOGISTS**, basis for paying part time (abs), 609
- RADIOLOGY**, graduate education in, 159
 role of, in treatment of cancer, 858
 therapeutic, relation of, to clinical medicine, 75
- RADIOSENSITIVITY** of cells, studies on (abs), 465
- RADIUM** element needles, low intensity, 467
 use of multiple sources of, within uterus in treatment of endometrial cancer (abs), 918
- RADON** seeds vs. radium needles, 469
- RECTOSIGMOID**, intramural extension of carcinoma of (abs), 292
- RECTUM**, roentgen diagnosis of malignant and potentially malignant lesions of (abs), 911
- REDUCTION**, open, of true congenital luxation of hip (abs), 602
- REMER, John**, 1862-1949, obituary, 894
 portrait, 894
- RENAL** osteodystrophy (abs), 156
- RESPIRATORY TRACT**: cancer of, in United States chromate-producing industry (abs), 446
 congenital obstructions of, 167, 177
 serialographic investigation in roentgen examination of (abs), 585
- RETICULO-ENDOTHELIOSIS**, 189
- RETROCARDIAC** shadows, differential diagnosis of (abs), 286
- RHEUMATOID** spondylitis, incidence and response to therapy among veterans of World War II (abs), 299
- RICKETS**, associated with the other skeletal diseases of infants and children, roentgen diagnosis of (abs), 455
 vitamin D-resistant, 742
- ROENTGEN** cinematography, studies of circulation by (abs), 458
 images, physical factors controlling diagnostic quality of, 870
 irradiation, fractionated external, histologic changes in squamous cell carcinoma of mouth and oropharynx produced by (abs), 611
 irradiation of hypophysectomized rat (abs), 775
 irradiation, total, in triton, time factor in lethal effects of, 550
 -ray diffraction (abs), 466
 -ray effects on protein content of rat intestine, 718
 -ray equipment, military field, 742
 -ray roll-film magazine, automatic, for angiocardiology and cerebral arteriography, 355
 rays in prevention and treatment of infections (abs), 917
 rays, lead glass fabric protective against, 740
 rays of various wavelengths, biological effects of, 252
 rays, soft, physical characteristics of, 91
 rays, supervoltage, physical basis for high skin tolerance of (abs), 775
 rays, 20 million volt, biological evaluation of, 555
 survey, chest, report on community-wide, at Minneapolis, Minnesota (abs), 585
 surveys, mass gastric, for control of gastric cancer, 574
 therapy, is it hazardous in benign bone lesions (E), 891
 therapy, rotation method of application (abs), 616
 therapy, use of three million volt (abs), 775
- ROENTGENOGRAMS**, double contrast, of stomach, 70
 routine, of wrist in pediatric service, value of (abs), 912
 upright, value of, in maternal pelvis at or near term, 707
- ROENTGENOGRAPHY**, intraoral, extended tube technique in, 881
 mass, minimal requirements for (abs), 282
 postreduction, of congenitally dislocated hips, laminagraphy through plaster casts in (abs), 465
 visual performance at, 631
- ROENTGENOLOGY**, pediatric, continuation course in, 441
- ROENTGENOSCOPIC** image, amplification of, 637
 screens, clinical potentialities of intensifying systems of, 635
 screens, intensification of, 617
- ROENTGENOSCOPY**, diagnostic, at chest clinic (abs), 282
 fluctuation theory applied to, 618
- ROTATION** therapy (abs), 616
- RUPTURE**, spontaneous, of esophagus (abs), 584

- SACROCOCCYGEAL teratoma in infancy (abs), 307
- SARCOMA arising in irradiated bone (abs), 464
 gastric, and carcinoma, distinctions between (abs), 592
 of urinary bladder in children, 843
 of uterus (abs), 596
 of uterus, generalized metastasis from (abs), 615
 ossifying hematomas mistaken for (abs), 599
- SCAPHOID, accessory tarsal (abs), 606
- SCAPULA, unusual anomaly of inferior portion of (abs), 601
- SCARS, hypertrophic, and keloids (abs), 609
- SCLERODERMA, generalized progressive, 359
- SCLEROSIS, primary, of solitary vertebra (abs), 604
- SCREEN intensification systems, 617
 intensifying systems, clinical potentialities of, 635
- SEDIMENTATION rate in asthma in children (abs), 152
- SEPTAL defect, interatrial, aberrant insertion of pulmonary veins associated with, 500
- SERIOGRAPH, automatic, 509
- SHOULDER hand syndrome (abs), 156
 joint, posterior dislocation of (abs), 601
 method of roentgen examination of (abs), 773
- SIDESWIPE fractures (abs), 157
- SIGMOID, completely obstructing annular carcinoma of, five year survival rate in cases of (abs), 291
 intramural extension of carcinoma of (abs), 292
- SILICOSIS, roentgen diagnosis of, and conditions simulating it (abs), 447
 see also ANTHRACOSILICOSIS
 significance of occupational history in diagnosis of (abs), 447
- SINUSES, chronic draining cutaneous, carcinoma developing in (abs), 772
 frontal, roentgen examination of (abs), 902
 paranasal, roentgen examination of (abs), 902
- SKELETON, diseases of, of infants and children, roentgen diagnosis of rickets associated with (abs), 455
 lesions of, in Hodgkin's disease (abs), 769
- SKIN and bone changes in leg, roentgen study of (abs), 157
 bone formation in (abs), 599
 physical basis for high tolerance of, to supervoltage roentgen rays (abs), 775
- SKULL, dysostosis of (abs), 901
 significance of certain measurements of, in diagnosis of basilar impression (abs), 584
- SOSMAN, Merrill C., Caldwell Lecturer, 1947, portrait opposite page 1
- SPHENOID bone, pulsating exophthalmos due to defective development of, 44
- SPINAL CORD, cancer of (abs), 295
 cervical, radiation myelitis of (abs), 917
- SPINE, calcification in intraspinal meningiomas, 237
 cervical, roentgenologic examination of, 380
 collapse of vertebral bodies in sickle cell anemia, 395
- connections of subarachnoid space of, with lymphatic system (abs), 294
- extradural cysts of (abs), 605
- fusion following removal of protruded nucleus pulposus, criteria for (abs), 605
- tumors of (abs), 305
- SPONDYLITIS, rheumatoid, incidence and response to therapy among veterans of World War II (abs), 299
- SPUTUM, value of cytologic study of, in diagnosis of carcinoma of lung (abs), 753
- STENOSIS, congenital pulmonary, aortic pulmonary anastomosis in (abs), 907
 mitral (abs), 905
 pulmonary, diagnosis of, by angiocardigraphy (abs), 591
- STILBAMIDINE, coexisting multiple myeloma and Paget's disease of bone treated with (abs), 307
 treatment of multiple myeloma with (abs), 917
- STOMACH, carcinoma, prognosis based upon Borrmann typing or presence of metastases (abs), 291
 diagnosis of lesions in and about fundus of, 738
 double contrast roentgenograms of, 70
 effect of common gastric drugs on motility of (abs), 153
 in femoral hernia (abs), 591
 mass gastric roentgen surveys for control of cancer of, 574
 new method of examination of mucosa of, by oil contrast, 564
 prolapse of mucosa of (abs), 153
 prolapse of redundant mucosa of (abs), 757
 roentgen examination of, in symptomless persons (abs), 449
 sarcoma and carcinoma of, distinctions between (abs), 592
 tumors of, diagnosis (abs), 758
- STRATIGRAPHY See LAMINAGRAPHY
- STREPTOMYCIN in treatment of chronic infections of bone (abs), 601
 in tuberculosis of bone and joint (abs), 298
- SUBARACHNOID space, spinal, connection of, with lymphatic system (abs), 294
- SUGAR tolerance, increased, as factor in production of symptom complex simulating peptic ulcer, and neurocirculatory asthenia and psychoneurosis (abs), 609
- SUPRARENAL neoplasms, calcification in (abs), 596
- SURGERY in bleeding peptic ulcer (abs), 450
 of ureteral calculi, roentgen control in, 113
 role of, in treatment of cancer, 858
- SYMPTOMS masked or modified by chemotherapy (abs), 608
- SYNOVIAL membrane, bone and cartilage debris in (abs), 303
- SYNOVITIS of hip joint, coxa magna following (abs), 158

- SYPHILITIC aortitis, angiocardiographic diagnosis of, 655
- TALUS, metastatic adnecarcinoma of, from recto-sigmoid region (abs), 768
 myxochondrosarcoma of (abs), 307
- TANNIC ACID, value of, in barium enemas, 739
- TAUTOGRAPH, advantages of, in cardiovascular angiography, 33
 development of, 33
- TECHNICIANS, dark room, training of blind for, 726
- TECHNIQUE, extended tube, in intraoral roentgnography, 881
- TERATOMA, sacrococcygeal, in infancy (abs), 307
- TESTIS, prognosis of tumors of (abs), 615
 radiation therapy of malignant tumors of (abs), 616
 tumors, radical orchiectomy for (abs), 460
- TRACHEO-ESOPHAGEAL constriction produced by right aortic arch and left ligamentum arteriosum, 493
- THORACIC cage, alterations in, in diagnosis of lung tumors (abs), 590
- THORACOTOMY, exploratory, in treatment of intrathoracic disease (abs), 444
- THORAX See also CHEST
 exploratory thoracotomy in management of intrathoracic disease (abs), 444
 non-malignant intrathoracic lesions simulating bronchogenic carcinoma (abs), 444
- THROMBOSIS, acute coronary, in perforating lesser curvature ulcer undergoing malignant changes (abs), 754
 unexplained, of internal carotid artery (abs), 280
- THYMUS GLAND, normal, study of roentgen anatomy of, with pneumomediastinum (abs), 586
- THYROID GLAND, nature of lateral "aberrant" tumors of (abs), 749
 of rat and man, formation of monoiodotyrosine from radioiodine in (abs), 774
- TIME FACTOR in cerebral angiography, 509
 in lethal effects of total roentgen irradiation in triton, 550
- TINEA CAPITIS, roentgen therapy for producing temporary depilation for (abs), 458
- TOXOPLASMOSIS, human, in England (abs), 280
- TRACHEA, malformations of, 167
- TRIANGULATION method of pelvimetry, simple pelvimeter to be used with (abs), 773
- TRITON, biological effects of roentgen rays of various wavelengths studied on, 252
 time factor in lethal effects of total roentgen irradiation in, 550
- TUBERCLE BACILLUS, disregarded seedbed of (abs), 283
- TUBERCULIN sensitivity in relation to pulmonary calcifications (abs), 753
- TUBERCULOSIS, and apical pulmonary carcinoma (abs), 590
 miliary, treatment of, with promizole (abs), 152
- of bone and joint, streptomycin in (abs), 298
 of cervical lymph nodes (abs), 749
 of hip, evolution and treatment of (abs), 454
 pulmonary, evaluation of planigrams in, 402
 pulmonary, in the old (abs), 283
 relation of idiopathic pleurisy and pleural effusion to (abs), 908
 roentgenologic diagnosis of (abs), 152
- TUMOR, benign giant cell, of bone, malignant degeneration of, 685
 dose in cancer of larynx (abs), 459
 so-called hemophilic pseudotumor (abs), 302
 Wilms', of kidney, radiation therapy for (abs), 918
- TUMORAL calcinosis (abs), 764
- TUMORS, abdominal, differential diagnosis of, 739
 deep-seated malignant, treatment of, with multiple port technique simulating rotation therapy (abs), 616
 extra-abdominal desmoid (abs), 460
 gastric, diagnosis of (abs), 758
 giant cell, of bone, comparison between anatomical and roentgen appearance of (abs), 770
 giant cell, of bone, malignant degeneration of (abs), 298
 intracranial, epilepsy secondary to (abs), 150
 lateral "aberrant" thyroid, nature of (abs), 749
 lung, alterations in thoracic cage in diagnosis of (abs), 590
 lymphoid (abs), 308
 malignant, of nasopharynx (abs), 151
 malignant, of ovary (abs), 760
 malignant, of testis, radiation therapy of (abs), 616
 mediastinal (abs), 750
 of glomus, roentgen diagnosis of (abs), 903
 of pituitary gland, origin and meaning of (abs), 903
 of testis, radical orchiectomy for (abs), 460
 of vertebral column (abs), 305
 primary malignant, of vesicovaginal septum (abs), 615
 pulsating benign giant cell, of bone (abs), 158
 solitary, of chest, 52
 suprarenal, calcification in (abs), 596
 testicular, prognosis of (abs), 615
 Wilms', clinicopathological study of (abs), 597
- 2,3,5-triphenyltetrazolium chloride solutions, radiation effects on, 559
- ULCER See Also PEPTIC ULCER
 duodenal, results following subtotal gastrectomy for (abs), 290
 duodenal, statistical study of life cycle of 1, 154 cases of (abs), 288
- UNITED NATIONS educational, scientific and cultural organization, 440
- URETER, deformities of bladder secondary to stone in, 670

- URETERAL calculi, roentgenologic control of, on operating table, 113
- URETEROCELES, very large, typical roentgen picture of (abs), 294
- URETEROGRAMS, unusual, in case of periarteritis nodosa (abs), 453
- URETEROPELVIC obstructions, symptoms and treatment (abs), 292
- URETHROCYSTOGRAPHY in male child (abs), 452
- URETHROGRAPHY in infants and children (abs), 762
- URINARY TRACT, accidental filling of, during barium enema (abs), 294
- calculi, radioactivity and (abs), 772
- changes in cervical carcinoma (abs), 763
- UROGRAPHY, intravenous, diagnosis by, of obstructive hydronephrosis produced by aberrant blood vessels (abs), 293
- intravenous, in study of vesical neck obstructions, 661
- UTEROSALPINGOGRAPHY, 741
- UTERUS, cancer, control of (abs), 610
- carcinoma of (abs), 461
- evaluation of vaginal smear method for diagnosis of cancer of (abs), 155
- rupture, roentgen demonstration of fetal death and, 837
- sarcoma (abs), 596
- sarcoma, generalized metastasis from (abs), 615
- use of multiple sources of radium within, in treatment of endometrial cancer (abs), 918
- VAGINA, smear method for diagnosis of uterine cancer, evaluation of (abs), 155
- VAGOTOMY (abs), 756
- gastrointestinal roentgen observations after, 738
- gastroscopic appearances following (abs), 756
- present status of in peptic ulcer (abs), 756
- VAGUS NERVE resections in treatment of peptic ulcer, results of (abs), 289
- VASCULAR rings, constricting (abs), 753
- system, peripheral, of lungs, roentgen appearance of chest in diseases affecting (abs), 906
- VEINS, calcification of, in Banti's syndrome (abs), 458
- pulmonary, roentgenographic and angiocardio-graphic aspects of aberrant insertion of, 500
- VERTEBRA, solitary, primary sclerosis of (abs), 604
- VERTEBRAE, echinococcus cysts, roentgen study of (abs), 604
- upper cervical, non-pathologic variations in relationship of, 519
- VERTEBRAL bodies, collapse of, in sickle cell anemia, 395
- column See SPINE
- VESICAL neck obstructions, intravenous urography in study of, 661
- VESICOVAGINAL septum, primary malignant neoplasms of (abs), 615
- VISCERA, pelvic, complete excision of, for advanced carcinoma (abs), 461
- VULVA, carcinoma, treatment of (abs), 613
- WAUGH-RUDDICK TEST, modified, use of, to study increased coagulability of blood, 541
- WISCONSIN RADIOLOGICAL SOCIETY, 577
- WRIST, value of routine roentgenograms of, in pediatric service (abs), 912
- XANTHOMATOSIS (abs), 284



AUTHOR INDEX TO VOLUME 62

* = original article

- Abowitz, Jacob, 293
 Acosta, Emilio, 455
 Adair, Frank E., 350
 Adair, Norman, 608
 Adams, Herbert D., 755
 Adams, John M., 752
 Adams, W. E., 445, 587
 Afifi, Mahmoud Ahmed, 580
 Agate, John N., 285
 Albers, Donald D., 763
 Albertengo, Juan B., 305
 Alicandri, B. Bruce, 773
 Allman, Francis C., 913
 Almy, G. M., 466
 Altman, Kurt I., 772
 Alvarez, Walter C., 580
 Amos, Luicille, 585
 Anderson, Johnson R., 569
 Appleman, Robert M., *881
 Arbuckle, Robert K., *52
 Archer, Vincent W., 184, 608, 740
 Ardran, G. M., 914
 Arkin, Alvin M., 300
 Arneson, A. N., 918
 Arnheim, F. K., 598
 Ashton, Dorothy L., 760
 Astley, Roy, 901
 Atwell, Susanna, 750
 Aurelius, J. Richards, *814
 Austin, George, 304

 Babaïantz, Léon, 297
 Babb, Frank Shaleen, 768
 Baclesse, F., *311
 Bailey, Percival, 745
 Barden, Robert P., 906
 Bargen, J. A., 759
 Barnettson, James, 158
 Bartelink, D. L., 304
 Bass, H. E., 771
 Bassler, Anthony, 592
 Bauer, Thomas B., 609
 Bauld, A. G., 613
 Baylin, G. J., 756
 Beadenkopf, William G., 753
 Beard, Rodney Rau, 588
 Beath, Thomas, 606
 Bell, Joseph C., *380, 911
 Bender, John R., 910
 Benioff, M. A., 446
 Bennett, T. R., 462
 Bergman, H. C., 448
 Bergmann, Martin, 590
 Berke, R., 771
 Bernstein, Charles, 905
 Berven, Elis, *320, 351

 Best, J. W., 615
 Beynon, A. E., 291
 Bickel, William H., 298
 Bielawski, John G., *247
 Birkelo, C. C., 736
 Birsner, J. W., *229
 Black, Marden, 443
 Black, William A., 292
 Blackman, Sam, 157
 Blades, Brian, 591, 750
 Blady, John V., 750
 Blanchard, A. J., 915
 Blanco, Pio, 307
 Bleich, Alan R., 458
 Blick, Michael S., 615
 Block, M. H., 465
 Block, Malcolm, 758
 Bloom, William, 580
 Bloomer, W. E., 285
 Boden, Geoffrey, 917
 Boldrey, E. B., 294
 Boone, F. H., 915
 Bothe, A. E., 772
 Bowden, Lemuel, 455
 Boyd, George A., 772
 Braasch, William F., 597
 Bradbury, F. C. S., 282
 Bradley, William F., 288
 Brailsford, James F., 599
 Bralow, S. P., 592
 Brasch, Arno, 775
 Brav, Ernest A., 306
 Breckenridge, Robert L., *388
 Brewer, Lyman A., III, 444
 Brierley, J. B., 294
 Brodny, M. Leopold, 452
 Brodsky, Alexander E., 307
 Brodsky, Edward, 609
 Bromer, Ralph S., 455
 Bronson, John F., 465
 Brown, Samuel, 739
 Brown, Webster H., 764
 Brummer, Perka, 153
 Brunschwig, Alexander, 461, 614
 Brunst, V. V., *252, *550
 Bryant, Henry C., 758
 Buchtala, V., 282
 Buckley, Robert W., 901
 Bulbulian, A. H., 736
 Bulgrin, James G., 283
 Bullock, W. K., 451
 Bundul, Alfred, 153
 Burchenal, Joseph H., 464
 Burford, T. H., 591, 755

 Cade, Stanford, *326, 352
 Cahan, William C., 464
 Caldwell, Guy A., 605
 Calme, A., 310
 Camp, John D., 456
 Carr, Charles E., *402
 Carson, M. J., 591, 753, 755
 Carter, Ray A., *509
 Casarett, George W., 772
 Case, James T., 82, 272
 Cassidy, William J., 913
 Castaldi, Luigi, 585
 Cave, Paul, 591
 Cavett, J. W., 151
 Charlton, E. E., 898
 Chatterton, Carl C., 768
 Cheney, William D., 773
 Chickering, W. A., 736
 Childe, Arthur E., 150
 Christie, Arthur C., 1, 739
 Clark, J. V., 904
 Clegg, Reed S., 302
 Coakley, H. E., 597
 Coe, Fred O., 739
 Coe, H. E., 599
 Cohen, Jonathan, 455
 Cohen, Mortimer, 596
 Coles, William C., 297
 Coley, Bradley L., 455, 464, 578
 Colp, Ralph, 756
 Comfort, Mandred W., 595
 Compere, Edward L., 766
 Concannon, Joseph P., *237
 Conti, James G., Jr., 593
 Cook, James C., 616, *685
 Cooley, A. G., 741
 Cooper, David A., 906
 Cooper, George, Jr., 608, 740
 Corcoran, William J., 447
 Corday, Eliot, 448
 Corrigan, Kenneth E., 740
 Costero, J., 903
 Costolow, William E., 610
 Cottler, Z. E., 453
 Cove, Arthur M., 757
 Cowing, Russell F., 740
 Crane, Peter, *418
 Craver, L. F., 308, 464
 Cravotta, Charles A., 596
 Crews, H. R., *707
 Crimm, Paul D., 590
 Cristol, D. S., 772
 Culp, O. S., 597
 Culver, Gordon J., *237, 287
 Cunningham, D. A., 740
 Curphey, Wilfred C., 757

- Darby, E. K., *257
 Davidson, Charles N., *837
 de Brux, J., 153
 Delario, A. J., 594
 Desjardins, Arthur U., *75
 Dexter, L., *777
 Diamond, L. K., 309
 Diddle, A. W., 462
 Diehl, William K., 763
 Dockerty, Malcolm B., 281, 291, 759, 772
 Dolley, Frank S., 444
 Donald, Dan C., Jr., 736
 Donaldson, S. W., 773
 Donlan, Charlotte P., 459
 Donnelley, Grace C., 613
 Dotter, Charles, *655
 Dotter, Charles T., 285, *355, 737, 754
 Doub, Howard P., *368
 Doubilet, Henry, 595
 Douglas, James B., *380, 911
 Dow, J. W., *777
 Dowell, D. Arnold, 917
 Downing, John E., 917
 Dratman, M. B., 308
 Dresser, Richard, 775
 du Toit, J. G., 605

 Edmonds, D. G., 465
 Edmonds, H. W., 599
 Edmondson, H. A., 451
 Edwards, Lydia B., 751
 Egeberg, R. O., 916
 Ehler, Adriana, 750
 Eisenberg, Richard B., 297
 Ellis, V. H., 599
 Ely, J. O., *718, *723
 Enell, Herbert, 156
 Engel, William J., *661
 Epstein, Bernard S., 465
 Esguerra-Gomez, Gonzalo, 455
 Etkin, Sidney I., 616
 Evans, Byron H., 444
 Evans, E. R., 916
 Evans, John A., 737
 Evans, William A., 448, 616
 Evans, William A., Jr., *167, *177, 738
 Evans, W. G., 904

 Fainsinger, M. H., 605
 Fairbank, H. A. Thomas, 457, 607
 Fairbank, T. J., 602
 Falconer, Ernest H., 769
 Farber, S., 309
 Farber, S. M., 446
 Faxon, H. H., 758
 Feldman, J. D., 749
 Feldman, Maurice, 288

 Felson, Benjamin, 737
 Felson, Henry, 737
 Ferguson, Ira A., 153
 Ferrer, Jose M., 290
 Fetterman, Faith S., 610
 Field, E. J., 294
 Fine, Archie, 739
 Fink, Kay, 774
 Fink, R. M., 774
 Fischmann, Joseph, 454
 Fisher, Bernard, 758
 Fisher, R. S., 453
 Fisher, Samuel H., 739
 Fishkin, B. G., 916
 Flance, I. Jerome, 590
 Fleischner, Felix G., *65, 282, 905
 Foltz, Thomas P., 593
 Foote, Frank W., Jr., 596
 Foster, Wm. C., 151
 Freeman, Norman E., 770
 Frey, W. B., 912
 Friedenber, Zachary, 304
 Friedman, Harold H., 156
 Friedman, Jack, *814
 Friedman, Louis J., *84
 Friedman, Milton, 611
 Fullenlove, Tom M., 741
 Furst, Nathan James, *798

 Gager, R. M., *91
 Gaja, Clemente, 584
 Gardella, Giovanni, 590
 Garland, L. Henry, *858
 Gaston, E. O., 465
 Gasul, Benjamin M., 761
 Gerber, Isadore E., 906
 Gerhardt, Paul R., 574
 Germansky, Geofred, 914
 Gershon-Cohen, J., 741
 Geyman, Milton J., 154
 Ghormley, Ralph K., 302, 768
 Giannardi, Goffredo, 586
 Gianturco, Cesare, *564, 741
 Gibson, Stanley, 907
 Gibson, T. W., 761
 Gierlach, Z. S., *559
 Gilbert, Rene, 157
 Gladsden, Eugene S., 756
 Glass, W. H., 593
 Glasser, Julius M., 761
 Goin, Lowell S., 910
 Gold, Aaron M., 606
 Golden, Ross, 374
 Goldenberg, H., 280
 Goldman, R., 916
 Gondos, Bela, *855
 Good, C. Allen, 736
 Goodfriend, J., 591, 753
 Goodman, Raymond D., *531
 Goodrich, William A., 909

 Gotham, Thelma J., 916
 Goyanna, Ruy, 597
 Graham, Evarts, 751
 Graham, Ruth M., 761
 Grant, Francis C., 304
 Gray, Howard K., 595
 Grayson, Charles E., *208
 Grayzel, D. M., 761
 Greene, Laurence F., 597
 Greenfield, Maurice M., 443
 Greenwood, Frank, 909
 Gregorius, Frederick, 446
 Grimoud, M., 298
 Grimson, K. S., 756
 Grishman, Arthur, *500
 Grohowski, Alphonsus L., 773
 Gross, R. E., 286, 594, 755
 Gross, S. W., 749
 Grossman, Aaron, 761
 Grotzinger, P. W., 772
 Guri, J. Puig, 305

 Haagensen, C. D., *328, 352
 Hackworth, L. E., 762
 Haden, W. Dan, 294
 Haight, Cameron, 444, 584
 Hall, Bernard, *670
 Hall, John W., 611
 Hall, Winston C., 758
 Hamann, Anna, 612, 757
 Hamm, F. C., 763
 Hampton, A. O., *707, 739
 Hanelin, Joseph, 765
 Hannan, J. R., 736, 910
 Hansen, Alton, 304
 Hanson, Joseph H., 741
 Hare, Hugh F., 308
 Harrington, E. L., *257
 Harrington, Stuart W., 281
 Harris, C. P., 435
 Harris, R. I., 606
 Hartman, F. W., 597
 Harvey, Harold D., 290
 Harvey, Rolfe M., 455
 Haslam, R. N. H., *257
 Hatch, Theodore F., 447
 Hatfield, W. H., *525
 Hawes, Cecil J., 292
 Hawes, Lloyd E., *831
 Hawley, Sydney J., 616
 Hayden, Henrietta S., 740
 Healey, R. F., *777
 Heath, Parker, 280
 Hebbel, Robert, 291
 Hebel, H. D., 740
 Heimoff, Leonard, *655
 Henkin, William A., *395
 Henline, Roy B., 292
 Henry, George W., *843
 Herbert, F. J., 283

- Herbst, William P., 293
Hertzog, Ambrose J., 584
Hiatt, Robert B., 451
Highsmith, LaRue S., 157
Higinbotham, Norman L., 455, 464
Hill, Frank J., 585
Hill, John E., *525
Hilleboe, Herman E., 574
Hilton, Gwen, 904
Hodges, Fred J., 643
Hodges, Paul C., 637
Hoffman, Jacob, 155
Hoffman, Olga R., 152
Holliday, Robert W., 283
Holman, Cranston, 737
Holmes, Edgar M., 901
Holt, John F., 742
Horst, H. G., 282
Horwitz, Thomas, 303
Hoster, H. A., 308
Howard, H. H., 453
Howes, William E., 773
Howorth, M. Beckett, 301
Howson, John Y., 155
Huber, Wolfgang, 775
Hueber, Franco, 584
Hughes, C. R., 736, 910
Hundley, J. Mason, 763
Hurwitt, Elliott, 286
- Irvin, G. E., 293
Irwin, W. A., *534
- Jackson, Chevalier L., 750
Jackson, Henry, Jr., 308
Jacobs, Lewis G., 296
Jacobson, L. O., 465, 612
Jacoby, N. M., 280
Jaffe, Henry L., 299
Janes, Joseph M., 768
Janus, William L., 287
Jauernig, Russell, *84
Jenkinson, E. L., *185
Johns, H. E., *257
Johnson, E. W., 768
Johnson, Robert W., Jr., 157
Johnson, Thomas A., 578
Jones, Dean B., 284
Jones, Glenn E., 773
Jones, Wilfred, 444
Joplin, Robert J., 765
- Kaplan, Gustave, 441
Kaplan, Ira I., 273, 616
Kardash, Theodore, 615
Karnofsky, D. A., 613
Kaster, J. D., 912
Katz, L., *257
Kaump, D. H., *534
- Keats, Sidney, 769
Keefe, Gerald J., 913
Keleman, George, 901
Kellett, M. A., 742
Kelly, James F., 917
Kendig, Tom A., 773
Kerley, Peter, 905
Kernohan, James W., 287
Kershner, Richard D., 445
Kerst, D. W., 466
Kesmodal, Karl F., 736
Key, J. Albert, 766
Khoo, F. Y., 601
Kilaidonis, P., 153
Kimbrough, Robert A., 610
King, Joseph E. J., 151
Kinsella, Thomas J., 584
Kipen, Charles S., 458
Kirklin, B. R., *159
Kirsner, Joseph B., 154, 757
Klein, Armin, 765
Kline, J. Richard, 287
Klos, H. J., 736
Kneidel, John H., *223
Koch, D. A., 736
Koenig, E. C., *237
Kraus, John E., 293
Krebs, A. T., *559
Kretschmer, Herman L., 454
Krieger, Charles I., 288
Kroll, John G., 740
Kuo, C. L., 601
- Lack, Herbert, 753
Lafferty, Robert H., 894
Lame, Edwin L., 741
Lanman, Thomas H., 450
Lanzl, L. H., 466
Lapidus, Paul W., 914
Larkin, John C., *547
Lavalle, L. L., 763
Lawrence, Edwin A., *418
Lawrence, John H., 309
Lawrence, Lewis R., *798
Legler, H., 282
Le Mesurier, A. B., 603
Lenègre, J., 153
Lenz, Maurice, 349
Leonard, Maurice E., 769
Lerner, Henry H., *418
Lester, Charles W., 749
Leucutia, T., 433, 616, *685, 740
Leveuf, Jacques, 602
Levin, Morton L., 574, 776
Levine, Bernard E., 905
Lewis, Ira, 751
Lewis, Lloyd G., 460
Lewis, Raymond W., 741
Lichtenstein, Louis, 299
Likely, Stanley David, 911
- Lincoln, Edith M., 152
Lindberg, E. J., 756
Lindsay, Stuart, 916
Linskog, G. E., 285
Lisa, James R., 911
Lischi, Giancarlo, 604
Liu, Ching Tung, 150
Livingston, Samuel, 152
Lobsenz, Herbert, *84
Lodmell, Elmer A., 287
Lofstrom, J. E., 736
Lohman, A. J. M., 905
Longstreth, H. Paul, 307
Loosli, Clayton G., 753
Losner, Samuel, 150
Loveman, Adolph B., 596
Löw, H. T., 597
Luce, Wilbur, M., *555
Lyford, John, III, 157
- McAnally, Albert K., 772
MacCarty, Wm. C., Jr., 737
McClenahan, J. E., 758
McClendon, J. F., 151
McCort, James J., *645
McCready, F. J., 759
McCune, Robert M., 594
McDonald, J. K., 454
McDonald, John R., 460, 736, 753, 763, 796
MacFarland, Catharine, 610
McGaw, W. H., 295
McGraw, John, 761
McGregor, M., 584
Machle, Willard, 446, 589
Mackay, Maurice W. H., 773
McKeever, Francis M., 765
Mackie, Thomas T., 588
Maclean, K. S., 908
Macmanus, Joseph E., 615
McMurray, Barry, 158
McRae, Donald L., 279
McWhirter, Robert, *335, 352
Mahoney, J. Francis, 458
Maimon, S. N., 154
Maisin, J., 459
Maloney, Walter H., 750
Manges, Willis F., 448
Mantovani, Dino, 595
Marks, E. K., 465
Marks, J. H., 463, 742
Maróttoli, Oscar R., 912
Marques, P., 298
Marshall, Samuel F., 289
Martin, Charles L., *467
Martin, Francis, *211
Mathis, William H., Jr., 903
Medlar, E. M., 283
Melamed, Abraham, 153
Mercer, R. D., 309

- Meschen, Isadore, 295
 Meyer, Alfred C., 281
 Meyer, Andrew H., 771
 Miller, David, *229
 Miller, Earl R., 770
 Miller, George A., 738
 Miller, Glenn F., *368
 Miller, J. E., 737
 Miller, Norman S., 461
 Mitchell, J. F. O., 901
 Mixter, W. J., 150
 Moffitt, Herbert C., 309
 Moir, William W., *519
 Molter, Howard A., 306
 Montgomery, John B., 760
 Moon, Robert J., 637
 Moore, George E., 291
 Moore, J. P., *707
 Moore, John Royal, 767
 Moore, Sherwood, *33, *375, *726
 Moreton, Robert D., 737
 Morgan, Russell H., 152, *617, *635, 644, *870
 Morgenstern, Philip, *402
 Morse, Russell W., 584
 Mortensen, Vagn, 905
 Moysés, José, 446
 Muckle, Craig W., 610
 Mulholland, John H., 595
 Mulry, William C., 308
 Mulvey, B. E., 910
 Munnell, Equinn W., 614
 Murphy, J. B., 466
 Musgrove, James E., 460

 Nabatoff, Robert A., 754
 Naffziger, H. C., 294
 Nalls, Walter L., *402
 Narins, Lester, *113
 Nathanson, Louis, 150
 Necheles, H., 592
 Neibling, Harold A., 288
 Nemec, Stanley S., 286
 Neuhauser, Edward B. D., 455, *493, 738
 Neuhof, Harold, 754
 Newcomb, Wendell J., 306
 Newman, Ernest, *113
 Nickell, David F., 291
 Nohrman, Bengt A., 459
 Nolan, James F., 773, 918
 Noonan, Thomas R., 772
 Norley, Theodore, 298
 Norris, Charles M., 750

 Ochsner, Harold C., 739
 O'Connor, Vincent J., 673
 Oldfelt, C. O., 156
 Oosthuizen, S. F., 158
 Ormond, J. K., 615

 O'Rourke, P. V., 736
 Ortmyer, M., 587
 Osborn, S. B., 465
 Overmiller, W. C., 771

 Page, Manley A., 608
 Palazzo, William L., *823
 Palmer, Carroll, 751
 Palmer, Walter L., 154, 757
 Partington, P. F., 451, 738
 Patrick, James, 767
 Paterson, Ralston, 270
 Patt, H. M., 775
 Paul, Lester W., *519
 Paulson, Moses, 756
 Peabody, George, *655
 Pearson, T. Arthur, 298
 Peightal, Thomas C., 614
 Pendergrass, Eugene P., 447, 458
 Pendergrass, Robert C., 911
 Pennybacker, Joe, 902
 Perry, S. Paul, 294, 445
 Peskin, A. Robert, 609
 Peterman, M. G., 912
 Peters, A. Gerard, 592
 Peterson, Harold O., *670
 Pfuetze, Karl H., 298
 Phalen, George S., 157
 Phemister, Dallas B., 767
 Piccioto, G., 904
 Piedmonte, M., 770
 Pirkey, Everett L., *70, 738
 Platt, Joseph L., 297
 Pollard, H. Marvin, 758
 Pomeranz, Maurice M., 396
 Ponseti, Ignacio, 454, 600
 Poppel, M. H., *500, *807
 Portis, Sidney A., 759
 Potter, Benjamin P., 906
 Potter, Robert M., 739
 Potts, Willis J., 307, 907
 Pouch, G., 298
 Present, Arthur J., 154
 Prinzemetal, Myron, 448
 Priviteri, C. A., 738, *807
 Pulcherio, J. B., Jr., 905

 Quastler, Henry, *555

 Rafsky, Henry A., 288
 Rakoff, A. E., 155
 Ramsey, George H., 773
 Rathburn, J. C., 913
 Ravitch, Mark M., 449, 594
 Reader, George, *655
 Reed, Edsel S., 738
 Reed, J. O., 740
 Reeves, Robert J., 742
 Reich, Carl, 307
 Reid, Douglas R. K., 593

 Reidy, John A., 765
 Reilly, William Anthony, 916
 Reynolds, Lawrence, 119, 740
 Rheinlander, Harold F., 738
 Rice, Frederick A., 753
 Richetts, W. E., 154
 Ricketts, Wm. E., 757
 Riebeling, Manuel, 917
 Rigler, Leo G., 449, *814
 Riker, William, 307
 Ritvo, Max, *211
 Roach, John F., *635
 Robert, Agrippa G., 447
 Robertson, E. Graeme, *44
 Robertson, Harold D., 773
 Robins, Samuel A., 452, 454
 Roche, Maurice B., 605
 Roemmich, William, 585
 Rollins, Stacy L., Jr., 736
 Rolnick, H. A., 308
 Ross, M. H., *718, *723
 Roswit, Bernard, 441
 Rowlands, S., 465
 Rowley, D., 465
 Rudhe, Ulf, 294
 Rundles, R. W., 756
 Rundles, Wayne, 742
 Ruoff, Andrew C., 769
 Russell, Dorothy S., 902
 Rutledge, David I., 755
 Ruzicka, Francis F., 287
 Ryan, Maxwell D., *715

 Sachs, Maurice D., 451, 738
 Sachs, Milton E., 754
 Sagorin, L., 280
 St. John, Fordyce B., 290
 Saito, Margaret Taiko, 588
 Salomon, Kurt, 772
 Samuel, Eric, 596, 909
 Sanchez-Perez, J. M., *509
 Sanes, Samuel, 307
 Sante, L. R., *788
 Saphir, William, 760
 Sauer, Hans R., 615
 Savitsky, Elias, 903
 Scanlan, Robert L., 456
 Schackelford, Richard T., 764
 Scheffey, Lewis C., 155
 Schein, Albert J., 300
 Scheinberg, S., 592
 Schenck, S. G., 918
 Schilling, John A., 773
 Schlesinger, Philip T., 769
 Schmitz, Herbert E., 461
 Schneider, Louis, 284
 Schneierson, Samuel J., 284
 Schoch, W. G., Jr., 758
 Schomer, A., 771
 Schulz, Milford D., 280, 297, 903

- Schwachman, Harry, 455
 Schwartz, Lois, 448
 Schwarz, Gerhart S., *359
 Scott, Roger B., 157
 Scott, Wendell G., *33, 591, 741
 Seedorf, Everett E., 737
 Selman, Joseph, 910
 Sengpiel, Gene W., 287
 Sengstaken, R. W., 290
 Setala, Kai, 774
 Shallow, Thomas A., 158
 Shapiro, Robert, 445
 Shatz, Burton A., 590
 Shaver, Cecil Gordon, 589
 Sheinmel, A., *807
 Sheppard, William B., 605
 Sheremetieva-Brunst, E. A., *252, *550
 Sherman, Mary S., 608
 Sherman, Robert S., 298, 456
 Shull, C. G., 466
 Silverman, Seymour B., *541
 Simmons, E. L., 465
 Simon, Samuel, 776
 Simpson, J. F., 904
 Simpson, R. S., *500
 Sirtori, C., 770
 Skaggs, L. S., 466, *555
 Skahen, Richard, 916
 Skinsnes, Olaf K., *359
 Slattey, Robert V., 753
 Slobody, Lawrence B., 914
 Small, John T., 288
 Smalldon, Ted R., 737
 Smith, C. A., 598
 Smith, Charles Edward, 588
 Smith, Robert E., 465
 Smith, Rodney, 746
 Smith, Taylor R., 612
 Smith, William H., 738
 Smyth, Michael J., 760
 Snapper, I., 917
 Solomon, Edwin P., 596
 Sornberger, C. Franklin, 308
 Sosman, Merrill C., *1, *777
 Souders, Carlton R., 755
 Spain, David M., 283
 Spalding, Charles K., 740
 Spatt, S. D., 761
 Speert, Harold, 614
 Spillman, Ramsay, 126, 570
 Spinelli, Vincent A., 903
 Spitzer, Norman, 156
 Spritzler, R. J., 448
 Spurr, Charles L., 612
 Stanbro, William W., 918
 Stanley, Robert R., 739
 State, David, 291
 Staton, H. J., 587
 Steele, James P., 773
 Stein, H. D., 911
 Steinberg, Charles Leroy, 912
 Steinberg, Israel, 285, *355, *655, 737, 754
 Steinbrocker, Otto, 156
 Sternbergh, Waldemar C. A., 456
 Stevens, G. Arnold, 593
 Stevenson, Clyde A., 737
 Stewart, Fred W., 464, 596
 Stewart, H. D., 465
 Stitch, Melvin H., 911
 Stone, Samuel, 152
 Strain, William H., 773
 Stranieri, Rodolfo, 595
 Straube, R. L., 775
 Sturgis, Margaret C., 610
 Sturgis, Somers H., 761
 Sturm, E., 466
 Sturm, Ralph E., *617
 Sussman, M. L., *500, 660
 Sutton, Richard L., 579
 Sutton, Richard L., Jr., 579
 Swenson, Orvar, 738
 Swenson, Paul C., 448
 Swift, M. N., 775
 Sylvester, R. F., 309
 Tabrah, F. L., 599
 Taggart, W. B., 587
 Tanner, Frank H., 764
 Tatelman, Maurice, *247
 Tattersall, W. H., 282
 Taylor, Grantley W., *341, 354
 Taylor, H. M., 756
 Temple, Harold L., *355
 Texter, E. Clinton, *534
 Thayssen, Viggo E., 460
 Thompson, Gershom J., 763
 Thompson, Harold L., 290
 Thompson, J. E. M., 764
 Tice, George I., 281
 Tobias, G., 446
 Toone, Elam C., Jr., 299
 Towne, Janet E., 461
 Treloar, Alan E., 291
 Trout, E. Dale, *91
 Trump, John G., 775
 Trusler, Harold M., 609
 Tuttle, W. M., 736
 Tuuri, Arthur L., 742
 Tyree, E. B., 775
 Tyson, M. D., 737
 Uhlmann, Erich M., 740
 Vandemark, Walter E., 604
 Vandre, Thomas E., Jr., 151
 Vermund, Halvor, 702...
 Verbo, Francesco, 604
 Vitt, Robert J., 602
 Voluter, Georges, 157
 Wagner, Frederick B., 158
 Walker, J. M., 587
 Walker, Lynn J., 153
 Wallace, William S., *189
 Walters, Waltman, 288
 Waltner, Jules G., *674
 Warburg, Erik, 905
 Ware, E. R., 916
 Ware, P. F., 594
 Warren, Richard, 450
 Warren, Shields, 749
 Warrick, C. K., 601
 Waugh, J. M., 292, 759
 Weber, Francis J., 585
 Weber, G., 280
 Webster, Bruce, *655
 Wechsler, I. S., 749
 Weingarten, Michael, 288
 Welch, Mark L., 289
 Welin, Soelvé, 902
 Wells, Josephine, 911
 Wertheimer, Luiz Gustavo, 300
 Westermarck, Nils, 445, 458
 White, J. C., 150
 Whitehouse, Francis R., 287
 Wiese, R. E., 736
 Williams, William A., Jr., 567
 Willner, Milton M., 914
 Wilner, Daniel, *388
 Wilson, James M., 595
 Wilson, James W., 288
 Wilson, John C., 765
 Wilson, John C., Jr., 601
 Wilson, Paul E., 451
 Wilson, Stanley A., 590
 Windeyer, Brian W., *345, 354
 Withee, John E., 737
 Wittenborg, Martin, 455
 Wittenborgh, Martin H., 463
 Wolfe, H. R. I., 280
 Wolff, J. A., 309
 Wollan, E. O., 466
 Woodard, Helen Q., 464
 Woolner, L. B., 736, 753
 Wright, H. P., 465
 Wyatt, George M., 739
 Wyatt, J. P., 280
 Wyman, Alvin C., 151
 Yakovlev, Paul I., 901
 Young, Arthur W., 150
 Young, Barton R., 745
 Young, H. Herman, 298
 Zadek, Sadore, 606
 Zatzkin, Herbert R., 452
 Zizmor, Judah, *715

S. M. S. Medical College, Japan

LIBRARY

Acquired by
Vermund, Halvor, 702...
Cl. Verbo, Francesco, 604

Date of Acq... ..

